[Established 1832]

THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE, INC.

140 NASSAU STREET, NEW YORK

J. S. BONSALL, Vice-President and General Manager

F. H. THOMPSON, Advertising Manager.

Editors:

E. A. AVERILL. OSCAR KUENZEL.

JULY, 1910

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In the M. C. B. convention the subject that received the most active discussion was the report of the committee on consolidation. There is evidently a quite natural and very decided disinclination among the more prominent members of this association to terminate its existence and strong arguments were advanced in support of this position. It would seem, however, to a disinterested observer as if the predominating weight of the argument favored the consolidation of the two associations. The committee report, which is given in another part of this issue, presented the subject in a very clear manner, and on the whole, although no definite recommendations were made by these committees, it favored the consolidation into an entirely new association. The whole matter, however, was very sensibly laid on the table for another year and it is probable that by the time of the next meeting the majority of members will have come to some conclusion that will permit at least the start of a movement which will eliminate the difficulties now existing.

The formation of a permanent technical bureau composed of active members of the association having thorough technical training, together with the officers of the association as members ex officio, was advocated by President Wildin in his address. He suggested that one member of this bureau be a salaried incumbent with a compensation which would permit a man fully equipped through experience and training to accept it. It was suggested that this bureau be clothed with authority to act for the associations on all important quesions coming up between the annual meetings and that it make a report of its activities to the associations at the next annual meeing. There is no doubt but what there is much work that such a bureau could handle to excellent advantage and the developments during the past year, particularly in connection with government activity on railroad questions, show the very great necessity for having some body of this character which can act as an official mouthpiece for the whole association on technical questions. Although no action was taken by the convention on this suggestion it was received with favor by many of the members and no doubt something of the kind will be done in the near future.

Saratoga is making a strong effort to have the meetings of the associations again held at that point and are prepared to present to the executive committees what they consider to be a very attractive proposition to bring it about. Among the members of the associations and of the Supply Men's Association there seem to be many who strongly favor returning to Saratoga for the next meeting and no doubt the arguments of the committee from that village will be seriously considered by the executive committees.

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MASTER CAR BUILDERS ASSOCIATION

FORTY-FOURTH ANNUAL CONVENTION.

ABSTRACTS OF COMMITTEE REPORTS AND PROCEEDINGS OF THE CONVENTION.

The first session of the forty-fourth convention was opened on Young's Million Dollar Pier, Atlantic City, N. J., on Wednesday, June 15, 1910, by President F. H. Clark, general superintendent of motive power, Chicago, Burlington & Quincy Railroad.

Following the address of welcome by Mayor Stoy, which was acknowledged by Past President W. E. Fowler, the president delivered his address.

President's Address.—After greeting the members, Mr. Clark drew attention to a number of matters in connection with the work of the association about which the members had not been informed, saying in part:

"One of the most important of these seems to be the present status of the safety appliance question as reported in full by our safety appliance committee. Congress passed a bill about two months ago, which received the signature of the President, and which provides that within six months from its passage the Interstate Commerce Commission, after hearing, shall designate the number, dimensions, location and manner of application of sill steps, hand-brakes, ladders, running boards and other parts mentioned in previous safety appliance acts. This bill provides that the rulings of the Interstate Commerce Commission shall be effective July 1, 1911, and that the commission may, upon full hearing and for good cause, extend the time after which any common carrier may be required to comply with the provisions of the act. The commission is also given authority, after hearing, to modify or change, and to prescribe the standard height of drawbars and to fix the time within which modification or change shall become effective. It was suggested about the time the bill passed that the hearing could be materially shortened and better results obtained if a conference was arranged between a committee of your association and the inspectors of the Interstate Commerce Commission, they to represent the commission; and, as the idea met with favor by Mr. Moseley, secretary of the Interstate Commerce Commission, and your executive committee, a special committee was appointed for the purpose. The American Railway Association authorized this committee to give such attention as might be necessary to the question of drawbar heights, a matter that had previously been handled by that association. A preliminary meeting on the whole subject was held on May 24, and subsequent meetings on June 6, 7 and 8, and, as a member of that committee, I would like to testify to the fairness and earnestness of purpose evidenced on both sides. I think it very likely that the final result will be a considerable expenditure of money on the part of the railways in bringing old equipment up to the desired standards, but it seems likely that at the public hearing the Interstate Commerce Commission will grant the railways reasonable time to make their existing cars comply with the rules which they will prescribe. A public hearing on height of drawbars was held by the Interstate Commerce Commission on the 7th of the month, and it is understood that an order will probably be issued prescribing 34½ inches as the maximum height and 31½ inches as the minimum height of couplers on standard gauge freight equipment, 26 inches as the maximum and 23 inches as the minimum height on narrow gauge freight equipment, except for two-foot gauge, where a maximum height of 17½ inches and a minimum height of 14½ inches is proposed.

This, I believe, will clear up the misunderstanding as to the intent of the present law, which has been given an interpretation somewhat at variance with the ideas of its framers.

It is probable that the public hearing on other details will be postponed until the early fall in order that the conference committees may be given all the time that will be necessary in which to reach their final conclusions. If in the end there are any points of difference between the office of the commission and the representatives of the railways, they will no doubt be settled by the commission at that time.

As I have already suggested, the orders of the commission may involve the railways of the country in considerable expense, this on account of the lack of uniformity in the application of safety appliances to our cars, and this is largely due to the fact that in some cases our safety appliance rules have not, until recently, covered some types of construction with sufficient clearness. Unfortunately, also, the association has not been in a position to enforce its rules, so that some variations have been allowed to continue which should have been corrected. The whole matter is now in the hands of the Interstate Commerce Commission, and your committee may regard itself, I suppose, as an advisory committee to that body. Where questions of safety are clearly involved there cannot very well be any serious differences of opinion, but the committee will take occasion to urge upon the officers of the commission the injustice of requiring uniformity when not essential to safety."

Following this, he drew attention to the fact that but a single case of the abuse of the repair card had been brought to the attention of the association during the year. A number of claims of sharp practice had been investigated and definitely disproved.

In connection with the report of the committee on consolidation the president said: "This is an important matter and one which should not be settled without a full comprehension of the points at issue. The matter has been proposed before, but the subject has never been brought to the point at which it now stands. I hope that it will receive your most careful consideration and that we shall all approach the subject without prejudice."

The death of the following members was reported: J. J. Ellis, P. H. Peck and J. F. Devine.

It was also announced that owing to the fact that the Master Car Builders' Association is an unincorporated body it will probably be unable under the laws of the State of New York to receive the Tilletson legacy of $5,000, bequeathed by the widow of a former member of the association.

SECRETARY'S REPORT.

Membership—Active, 377; representative, 332; associate, 14; life, 19; total, 742. Number of cars represented, 2,298,633.

Financial—Income, $16,509.50; expenses, $15,919.20; balance, $590.21. The balance now in the treasury is $1,127.82.

During the year fourteen railway and private car lines have signified their desire to become subscribers to the rules of interchange governing freight cars. Nine railways and private car lines have accepted the code of rules governing the interchange of passenger equipment.

ELECTION OF OFFICERS.

The following officers were elected for the ensuing year:

T. H. Curtis, president.

A. Stewart, C. E. Fuller and D. F. Crawford, vice-presidents.

John S. Lentz, treasurer.

J. D. Harris, C. E. Fuller and C. A. Seley, members of the executive committee.

J. F. Deems, A. W. Gibbs, C. A. Seley, W. H. Lewis and J. F. Walsh, committee on nominations.

RULES FOR LOADING LONG MATERIALS

The committee recommended a number of changes in the rules, all of which were referred to letter ballot with the exception of the sections referring to fixing the center of gravity of superimposed loads at 9 ft. 3 in. and the use of metal spacing blocks.

REVISION OF THE RULES OF INTERCHANGE.

Most careful study and consideration in effecting all the improvement possible in the code of rules was evident in the committee's report. Changes of varying importance were made in a large number of the rules and a rearrangement of all rules to bring related parts closer together were presented.

The report of this committee was accepted with a rising vote of thanks and will be submitted to letter ballot.

A letter from W. H. Lewis on the subject of the abuse of the repair card was read by the secretary. After a brief discussion, which developed the fact that there had been a big improvement in this respect during the year, a motion was carried to the effect that all members submit to the executive committee by letter any cases of abuse of the repair card that come to their notice.

SAFETY APPLIANCES.

Committee:—C. A. Seley, chairman; A. LaMar, T. H. Curtis, C. B. Young, H. Bartlett and T. M. Ramsdell.

The committee regrets having no report for this year, account of pending legislation in the matter of safety appliances. The status of the matter is as follows: During the present session House Bill 5702, passed last year in the house, was taken up, and, after a number of amendments, was passed by both houses and signed by the President, thereby becoming a portion of the Interstate Commerce Law.

Section 2 of the law brings more of the details of cars under scrutiny than was called for in the old acts, namely, sill steps, hand brakes, ladders, running boards and roof handholds. A proviso is also added, covering the case of loading of long commodities requiring more than one car, and it is also understood that hand brakes are not required on logging cars and other vehicles exempted by the primary acts.

Section 3 authorizes the Interstate Commerce Commission to designate the number, dimensions, location and manner of application of the appliances covered by these acts after notice and hearing. Inasmuch as the hearing has not been held, the committee has no definite information as to whether the M. C. B. standards will be acceptable to the Interstate Commerce Commission or not, and until such hearings definitely decide on this point, the committee has felt that any efforts on their part might be wasted labor.

Section 4 provides for movement of bad-order cars for repairs as has been a practical necessity in the past, although such movements would be illegal were the laws strictly construed. The new arrangement gives welcome relief in this respect by permitting the car to be hauled to the nearest available repair shop without liability, except in case of danger to employees during such movement, which is properly provided for.

It is quite possible that special instructions will be issued by the executive committee or by this committee under instructions of the executive committee after the Interstate Commerce Commission hearings have been held and the safety appliances defined.

The report of the committee was adopted, and the executive committee was directed to send a statement to all members fully explaining the position taken by the Interstate Commerce Commission on the matter of standards.

REVISION OF STANDARDS AND RECOEMMNDED PRACTICE.

Committee:—R. L. Kleine, chairman; Jno. Hair, T. M. Ramsdell, W. E. Dunham, and T. H. Goodnow.

The committee recommended changes in the following parts:

STANDARDS.

Standard Axles—Fillets at back end of journal.

Brake Beams—Revision of text.

RECOMMENDED PRACTICE.

Limit gauges for inspecting second-hand wheels for remounting be advanced to a standard.

Brake Beams—Advancing to standard the following: "That brake beam hanger brackets shall be attached to some rigid portion of the truck."

Carrier Iron—Advancing to standard the following and changing title to "Brake Staff Carrier Iron": Use of U shape carrier iron on new cars.

Knuckle Throwing Device—Advancing to standard after Sept. 1, 1911, the following: "That the use of a knuckle-throwing device which will throw the knuckle completely open and operate under all conditions of wear."

The adoption of the following: Doors, door jambs and all other inside exposed corners of stock cars to be rounded to prevent injury to cattle. Add cut to sheet M. C. B.—F. showing the construction.

Committee recommends the appointment of a special committee to determine whether any changes in the present limits for round iron are necessary, and, if so, to fix new limits. This matter requires investigation before establishing any new limits, on account of the effect increased limits would have upon the standard screw threads used.

Discussion—After some discussion the recommendations of the committee in connection with roof boards were eliminated from the report, which was then accepted. A motion to eliminate the reference to gauge for second-hand wheels was lost.

CLASSIFICATION OF CARS.

Committee:—J. Milliken, Chairman, F. M. Whyte, J. N. Mowery.

At the meeting of the American Railway Association, held April 22, 1908, the following resolution was adopted:

"*Resolved,* That the Master Car Builders' Association be requested to take up the question of harmonizing the terms used in designating the different classes of cars and the different kinds of cars in each class, according to their physical characteristics, and report its recommendations to this Association for final action."

The committee feels that the American Railway Association desired a classification of cars more from a transportation, than a detail construction, standpoint, and therefore, presents a Classification of Cars, divided, first, into Passenger Equipment Cars; second, Freight Equipment Cars; third, Maintenance of Way Equipment Cars; and these classes, in turn, subdivided into distinctive classes of cars, principally in order to facilitate the work of car distribution and car efficiency.

We have not taken into consideration the individual physical characteristics, such as kind of trucks, draft gear, or other details of construction of a car, as we understand the principal questions to be answered are "what kind of a car" and "how much will it carry."

The rolling equipment of forty-three railroads, operating 117,500 miles of track, and owning, approximately, 1,350,500 cars, has been looked into, and it is found to be impracticable to make a definite classification giving the individual characteristics of the cars that would, in any way, be applicable to the equipment of the various railroads of the United States.

It would, therefore, seem that the classification should be broad in its interpretation, and confined only to kind of car of general class and the stenciled capacity of the car. With passenger cars, the kind of car, and length and seating capacity should be indicated, and possibly the manner of lighting.

In arriving at the proposed classification of cars a single designating letter has been given for the general service of the car and a secondary letter to cover the general type of the car. In arriving at the primary and secondary letters, the attempt has been made, as far as practicable, to give letters which give some indication of the type of the car, or letters that are now generally used.

DEFINITIONS AND DESIGNATING LETTERS OF GENERAL SERVICE PASSENGER EQUIPMENT CARS.
CLASS "B."

"BA"—Baggage Car. A car run in passenger service, having wide side doors for the admittance of baggage, with or without windows or end doors.

"BE"—Baggage Express. A car similar to baggage, used for either baggage or express matter.

"BH"—Horse or Horse and Carriage Express. A car run in passenger service for the transporting of fine stock, fitted

with stalls (movable or stationary) and space left for carriage or horse equipment.

"BR"—Refrigerator Express. A car run exclusively in passenger service and fitted with ice bunkers or boxes, and suitable to carry produce, oysters, fish, or any commodity requiring icing in transit.

"BX"—Express Car. Exclusively for express matter, having suitable side doors, with or without end doors or windows.

CLASS "C."

"CA"—Combined Car, Baggage and Passenger. A car having two compartments, one suitable for transporting baggage, the other fitted with seats for passengers, the two compartments separated by bulkheads.

"CS"—Combined Smoking and Baggage Car (Club Car). A car having two compartments, separated by bulkheads, one compartment suitable for transporting baggage, the other fitted with seats or chairs and used as smoking car; at times equipped with buffet or bar.

"CO"—Combined car having three separate compartments, separated by bulkheads, one compartment suitable for transporting baggage, one for mail fitted with suitable apparatus for sorting and classifying mail, and the other fitted with seats for the transportation of passengers.

"CB"—Business Car. A special type of car for the convenience of business men, used as smoker and fitted with tables or desks, carrying stationery and fitted with typewriters and carrying regular stenographers.

CLASS "D."

"DA"—Dining Car. Regular dining car, for the use of passengers in transit, fitted with regular kitchen, tables, chairs or seats, with or without bar, carrying cooks and waiters.

"DB"—Buffet Car. Car for the transportation of passengers and fitted with small broiler or buffet to serve simple meals to passengers; cooking and serving done on removable tables by regular porter in charge of car. With or without facilities for serving liquor.

"DC"—Café Car. A car fitted with kitchen, usually in center of car, one end used as café where meals are served, also liquor and smoking allowed, the other end of car fitted with either regular dining room or smoking and card room; carrying cooks and waiters.

"DG"—Grill Room Car. Very similar to café car.

"DO"—Café Observation Car. Car fitted with café at one end, kitchen in center or extreme end, having observation compartment fitted with stationery or movable tables and observation platform at rear.

"DP"—Dining and Parlor Car. A car fitted with dining compartment, kitchen and compartment for passengers, fitted with chairs, stationary or otherwise, carrying regular cooks and waiters.

CLASS "E."

"EA"—Electric Street Railway Service Car, direct current, for transportation of passengers; without automatic couplings.

"EP"—Electric Passenger Car, for long hauls or suburban service, multiple unit and fitted with automatic couplings and air brakes. Third rail, trolley or pantagraph contact.

"EB"—Electric Baggage Car, for long hauls or suburban service, multiple unit with automatic couplings and air brakes and suitable for the transportation of baggage. Third rail, trolley or pantagraph contact.

"EM"—Electric Mail Car, for use in United States Mail Service, fitted with side doors, with or without mail hook, and suitable apparatus for the sorting and classifying of mail en route. With or without end doors or windows.

"EC"—Electric Combined. A car for long hauls or suburban service, multiple unit with automatic couplings and air brakes. This car is made up of two compartments, separated by bulkhead, one suitable for the transportation of baggage and the other fitted with seats or chairs for the use of passengers. Third rail, trolley or pantagraph contact.

"EG"—Gasoline Motor Propelled Car, for inspection or private use, or use in suburban service, hauling one or more trailers.

"ED"—Gasoline Motor Car. Gasoline engine or engine serving to run dynamo to furnish electricity for axle motors. Car to be used for inspection, private use, or as motive power to haul trailer or trailers; fitted with storage cells and with or without booster.

CLASS "M."

"MA"—Postal Car. For use of United States Mail Service, fitted with side doors, with or without mail-bag hook, and having suitable apparatus for the sorting and classifying of mail in transit, with or without end doors or windows.

"MB"—Baggage and Mail. A car having two compartments, one for baggage and one for mail, separated by bulkheads; the mail end fitted with suitable apparatus for sorting and classifying mail, and with or without mail-bag catchers, with or without end doors or windows, and having suitable side doors.

"MP"—Postal Car. Suitable for transporting newspapers or large mail packages for United States Mail Service, having side doors and fitted with stanchions, with or without end doors or windows.

"MR"—Postal Storage Car. For United States Mail Service, suitable to carry mail in bulk, without appliances for sorting or classifying, fitted with side doors and stanchions and with or without end doors or windows.

"MS"—Mail and Smoker. A combined car having two separate compartments, separated by bulkheads, one compartment suitable for the transportation, sorting and classifying of mail, the other fitted with seats or chairs to be used by passengers as smoking car.

CLASS "P."

"PA"—Passenger Car. A car for ordinary short haul suburban service, with seats and open platforms.

"PB"—Passenger Car. A vestibule (wire or narrow) car for through service, fitted with seats or reclining seats, and having toilet rooms for men and women, also wash basins.

"PE"—Emigrant or Colonist Car. A second-class passenger car, with floors either bare or fitted with matting, used expressly for emigrant trade on trains where low rate of fare is charged.

"PS"—Sleeping Car. A car for passenger service having seats that can be made up into berths, and usually having one or more separate stateroom compartments, also toilet and washroom facilities for men and women, and smoking compartment for men. Some cars of this class are all compartments, and some compartments and observation combined.

"PN"—Passenger car used exclusively as smoking car, with seats or chairs and fitted with cuspidors or having matting or bare floor.

"PO"—Observation Car. A car having observation compartment at one end and fitted with either berth facilities, parlor chairs or compartments, usually run in first-class service.

"PV"—Private car used as officers' or private individual's car and railroad pay car—usually composed of sleeping compartments, dining compartments, observation end and with kitchen, servant's quarters and toilet and bathroom.

"PT"—Tourist Car. A second-class sleeping-car, fitted usually with cane seats convertible into berths and used mostly on trans-continental trains; cars fitted with smoking compartment, toilet and washroom.

"PC"—Passenger, Parlor or Chair Car. A car fitted with individual stationary or movable chairs, used on trains for daylight runs and having toilet and washrooms.

CLASS "I."

"IA"—Instruction Cars for use of employees, usually run from one point to another in passenger trains.

NOTE.—If it is to be desired, a small letter "E" can be placed after the larger designating letters to indicate electric lighting, and small "G" for gas lighting, also figures showing approximate length of car or length of baggage or mail compartment.

GENERAL SERVICE FREIGHT EQUIPMENT CARS.

CLASS "X."

"XM"—Box Car. General service, suitable to lading which should be kept from the weather. A box car is a closed car having side and end housings and roof, with doors in sides or sides and ends.

"XA"—Automobile Car. Box car of similar design to general service car, having exceptionally large side doors or end doors.

"XF"—Furniture Car. Box car of similar design to general service car, except usually greater capacity in cubic feet.

"XV"—Box Car, Ventilated. Similar to ordinary box, only having ventilation, and suitable for the transportation of produce or other foodstuffs not needing refrigeration.

CLASS "R."

"RM"—Refrigerator or Produce Car. A car suitable for carrying commodities that need icing in transit. This car is equipped with two or more ice bunkers or baskets and suitable means of draining off melted ice or briny water. This car has side and end housings, roof and side doors, usually insulated, with trap doors in roof for admittance of ice and salt; also water seals inside of car.

CLASS "S."

"SM"—Stock Car. This car is for transportation of stock on the hoof, and is equipped with roof, slatted sides and side doors, and single or double deck. With or without feed or feed and water troughs.

"SD"—Stock Car. Composite having drop doors in floor and means of housing in sides and making drop-bottom box car.

"SP"—Stock Car. Used in poultry trade, fitted with roofs and sides usually of wire netting, fitted with shelves for storing crates of poultry and leaving space for poultrymen, feed bag and watering facilities.

CLASS "G."

"GA"—Gondola Car. This car has sides and ends open at top,

and drop bottom; suitable for general coal or ore trade, stone or general trade.

"GE"—Gondola car having drop bottoms and drop sills; suitable for general coal or ore or mill trade.

"GC"—Gondola Coke Car. Gondola car fitted with coke racks and having drop bottoms.

"GD"—Gondola car having side-dump arrangement.

"GM"—Gondola Car. Suited to mill trade, having solid bottom, low sides and drop ends to facilitate twin shipments.

CLASS "H."

"HM"—Hopper Car. Similar in general design to gondola car, having sides and bottom ends and open at top, equipped with hopper bottom and self-cleaning.

"HT"—Hopper (Twin). Similar to ordinary hopper, only equipped with two or more hopper doors instead of one.

"HD"—Hopper car equipped with side-dump hoppers.

"HC"—Hopper car equipped with coke racks.

CLASS "F."

"FM"—Ordinary flat car for general service. This car has flooring laid over sills and without sides or ends.

"FG"—Flat or gun truck car for special transportation of heavy ordnance.

"FW"—Flat well-hole car for special transportation of plate glass, etc. This car is a flat car with hole in middle to enable lading to be dropped down on account of clearance limits.

"FB"—Flat car having skeleton superstructure, suitable for carrying barrels, known as "Barrel Rack Car."

"FL"—Flat logging car or logging truck. This is either an ordinary flat car, or car consisting of two trucks fitted with cross supports over truck bolsters; the trucks connected by a skeleton of flexible frame and logs loaded lengthwise on cross supports.

CLASS "T."

"TM"—Tank car for general service. This car is for general oil or liquid service, and consists of a steel tank mounted on frame or mounted directly on cradles over truck bolsters. It is equipped with one or two safety release valves, and is emptied by valves or valve at bottom. At the top is a dome, with or without manhole, and openings through which the tank may be filled.

"TA"—Acid Tank. Of same general construction as oil tanks.

"TG"—Tank car having glass or glass-lined tanks, for use in hauling mineral waters and other special products.

"TS"—Tanks for special commercial service.

"TW"—Tank car having wooden tank, instead of steel, and used for water, pickles, etc.

CLASS "N."

"NM"—Freight train service caboose for convenience of trainmen. This caboose is mounted on four wheels and has lookout at top over roof. It is fitted with bunks or benches and a stove for cooking and heating purposes, also tank for storage of drinking and washing water, and small tool storage boxes.

"NE"—Caboose mounted on eight wheels and longer than four-wheel caboose, but of the same general design.

CLASS "Y."

"YM"—Yard Poling Car. This car used in hump classification and flat-yard classification. This car is usually fitted with small house for protection and benches, tool box and stove, a counterweighted pole on each side and running board or step near the ground for convenience of yardmen. It is protected with safety appliances and, when in use, coupled to an engine.

"YA"—Yard pick-up car for use of car droppers and yardmen in performance of their duty. It might be termed a "Car Dropper's Car." It is protected by a house, around which runs a platform and railing, a long running board on sides near ground and is fitted with benches, tool box and stove.

NOTE.—The capacity of car can be shown by affixing two figures after designating letter: for instance, "80" would mean 80,000 pounds capacity; "10" would mean 100,000 pounds capacity; "60" would mean 60,000 pounds capacity. Where tanks are in question the capacity numbers should indicate capacity in gallons instead of pounds.

GENERAL SERVICE MAINTENANCE OF WAY EQUIPMENT CARS.

"MWB"—Ballast Cars. All descriptions of cars used for the purpose of carrying ballast for the laying of new right of way and repairs. The car used generally for this work is of the gondola type, with side or center dump.

"MWD"—Dump Cars. On the type of contractors' car used for building up fills; the body of the car dumps, being raised by means of counterweight, air or hand power.

"MWF"—Flat Car. Used for transporting rails, ties or ballast and for storage of wrecking trucks, or gathering scraps along right of way. These cars are at times equipped with low sides, about 10 or 12 inches high.

"MWS"—Steam Shovel. Car equipped with donkey engine housed in. Having a boom of wood or steel and the end of which is a shovel or scoop. It may be propelled by its own power or by means of a locomotive and run as a car in freight trains, being equipped with safety appliances. The cubic capacity of shovels, in yards, can be indicated by figures after classification letters.

"MWW"—Wrecking Derrick. A derrick used for wrecking purposes, having donkey engine to raise and lower booms and hoists; engine housed in and on separate platform with boom, is pivoted in center of car frame in order that it can be worked on either sides or ends; usually fitted with anchor beams to be used for heavy lifting. Fitted with safety appliances and propelled by means of locomotive. Lifting capacity in tons shown by means of figures.

"MWU"—Wrecking Derrick. This derrick has boom and hoist fitted to frame of flat car and lifting done by means of hand power; propelled by locomotive.

"MWV"—Wrecking Derrick. This derrick has boom and hoist fitted to flat car and having drum at one end to furnish means of hoisting; steam furnished to donkey engine, running drum, by means of flexible steam line from attached locomotive; propelled by locomotive.

"MWT"—Tool and Block Car. A car used for carrying all descriptions of tool equipment and blocking. This car has side and end housings and roof, also end platforms. There are doors in sides and ends and usually windows. It is fitted inside with proper racks and boxes for storage of tools.

"MWC"—Caboose and Tool Car. Similar to tool car, but having one end fitted up as a caboose, with bunks, stove and water storage, with or without lookout, and is used in either work or wrecking trains.

"MWH"—Hand Car. This car is flat and mounted on four wheels and propelled by means of pushing, known as "Push Car."

"MWL"—Hand Car. This is a small flat car, with or without seats, mounted on four wheels and propelled by means of cranks or hand levers.

"MWG"—Section Gang or Track Inspection Car. Flat car, with or without seats or tool boxes, and equipped with single or double cylinder gasoline engine serving as motive power.

The report of the committee was not discussed and on motion it was approved and referred to letter ballot.

COUPLER AND DRAFT EQUIPMENT.

Committee:—R. N. Durborow, Chairman, G. W. Wildin, F. W. Brazier, T. H. Curtis, F. H. Stark, Thos. Roope, W. E. Symons.

The standing committee on coupler and draft equipment submitted the following report:

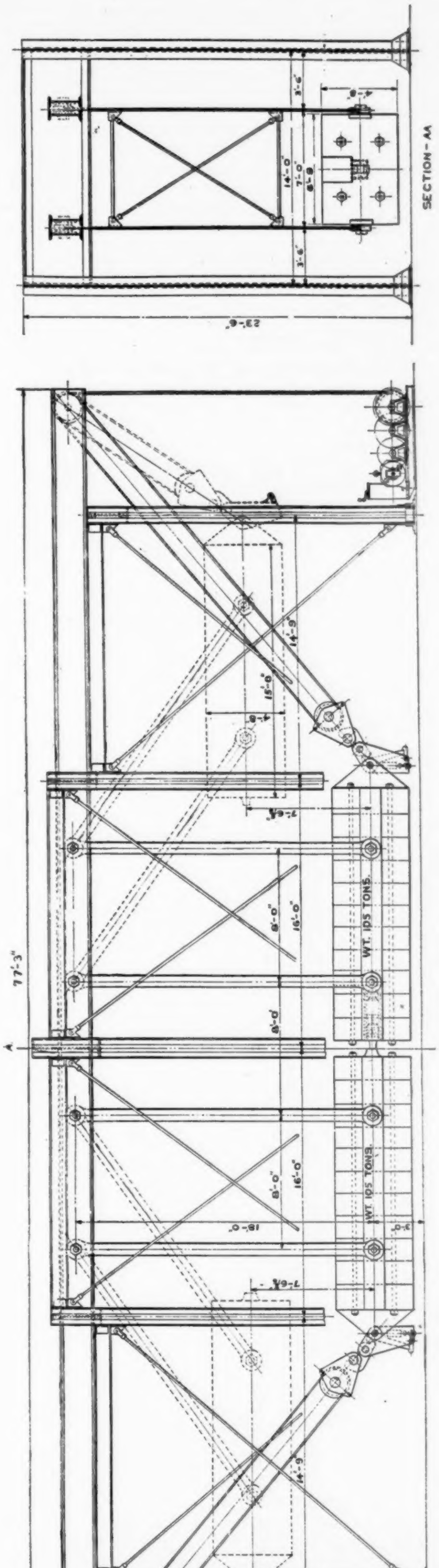
SPECIFICATIONS.

Size of Eyelet for Lock-lift Device.—In order that the text of the Standards for Automatic Couplers may agree with Sheet 23, it is necessary that the size of eyelet in locking device be added making the tenth paragraph on page 611 read, "That all couplers must have a 1 1-16-inch eyelet for unlocking device located immediately above locking pin hole."

Gauges for Knuckle Pivot Pins.—The first sentence in the third paragraph of the specifications for M. C. B. automatic couplers should be changed so as to include knuckle pivot pins, as follows: "Bars, knuckles, locking pins or blocks and knuckle pivot pins must be accurately made to gauges furnished by the manufacturer," in order to insure interchangeability.

Use of Knuckle-throwing Devices.—The requirement providing that the coupler must be equipped with an efficient knuckle-throwing device has now been a Recommended Practice for a period of five years, and nearly all of the modern couplers in use to-day are provided with some form of knuckle-throwing device. While all of the knuckle-throwing devices in use are not as efficient as the committee believes they should be, it feels that this requirement should be advanced to Standard, incorporating the following: "All couplers must be equipped with a knuckle-throwing device which will throw the knuckle completely open from any position it may assume in service." If this recommendation is adopted as Standard it should be embodied in the Standards in Section 4 of the Specifications for M. C. B. couplers after September 1, 1911, thereby giving time to the manufacturers of couplers which do not at present meet this requirement to improve their models to conform with this specification.

Lock-bearing Area.—The question of adopting a minimum allowable area of effective bearing surface between the knuckle tail and lock, and stipulating that there shall be at least as much bearing between the lock and wall of coupler, has been presented to the committee, with a view of making that minimum as large as possible, in order to insure a better distribution of pressure and consequently a less rapid wear. The commit-



MACHINE FOR TESTING FRICTION DRAFT GEARS.

tee suggests that 4 square inches be adopted as the minimum allowable area of these bearing surfaces. Of course, a larger bearing surface is desirable, but in fixing 4 square inches as a minimum at this time, the committee feels that no great hardship will be imposed upon manufacturers of existing types of couplers, and that as conditions improve this limiting area may be increased.

Twist Gauge.—The twist gauge shown on the present M. C. B. Sheet "C" should be abolished, as it has not proven useful. After an extended trial it has been found that any distortion of the coupler which this gauge would indicate could easily be detected by the eye, and, therefore, the use of the gauge was discontinued. Had this gauge proven of benefit it would have received recognition long ago by being advanced to Standard.

Shelf Brackets.—The committee desires to call the attention of the members to the fact that shelf brackets, designed to hold the uncoupling lever in a raised position, are still in use by a number of roads, on cars which are equipped with couplers conforming to the present standards. These brackets were to be abolished in accordance with the letter ballot of 1907 and, therefore, should not be allowed to remain on cars having standard couplers for the following reasons:

First: That it destroys the feature of the lock set within the head of the coupler; in other words, when the lever is locked in a raised position it must be released again by hand before coupling can be effected.

Second: The use of the inclined shelf bracket allows the rods to be locked in a raised position so that the chain is frequently taut. In case of couplers equipped with a knuckle-throwing device, when the knuckles are closed, the tail of the knuckle will strike the opener, and either bend it out of line or break the uncoupling chain. This is more pronounced in couplers where allowance is made for play of ⅜ inch behind the tail of the knuckle, as recommended in the specifications.

FRICTION DRAFT GEAR.

General Review.—The report of the committee of last year called attention to two means of obtaining definite information desired concerning the performance of draft gears, namely, by means of a series of road tests with accurate recording apparatus, and the design of a laboratory testing apparatus which will subject the draft gears to approximately the same pressures and shocks received in service.

After careful consideration, the conclusion was reached that the results to be obtained from both investigations could be combined in the latter, providing the action of the draft gears in such a laboratory testing apparatus would approximate service conditions, with the additional advantage of saving time and expense of making actual road service tests.

To make a series of service tests would necessitate equipping trains composed of cars of various types with each kind of draft gear in turn, with resulting loss of time in applying each set of draft gears during a period when there may be a great demand for cars, to say nothing of the expense involved.

The possibility of using a drop-test machine, using either the standard M. C. B. weight of 1,640 pounds or a heavier one, was considered, but the action of the draft gears under the forces of impact delivered by such a machine was found to differ greatly from their action in service, making this form of drop test undesirable.

The use of any kind of static machine would be unsatisfactory, because the load is applied slowly and does not approximate service conditions.

Draft Gear Testing Machine.—In order to place the draft gears in a laboratory testing machine so as to undergo service conditions, a machine has been designed on the principle of the double pendulum, of which the illustration shows the general arrangement.

Each pendulum weighs 210,000 pounds, which represents the probable maximum weight of a car and lading which will be encountered in service.

Provision is made for swinging each pendulum through an arc sufficient to give a maximum speed of fifteen miles per hour when at the lowest point of swing, so that with one pendulum at rest and one in motion speed up to that limit is obtainable, and with both pendulums in motion a maximum speed at the point of contact of thirty miles per hour is available.

By using the pendulums many uncertain variables are eliminated, such as the motion between trucks and car body, the shock absorbed by the truck springs, resistance offered by wheel flanges on curves, etc., which would interfere with satisfactory observation in a road service test.

The resistance offered to each blow and the force of the blows delivered at the different speeds is constant for each draft gear, making the results directly comparable.

In the illustration a draft gear is shown mounted in one pendulum, the other being simply a solid weight with a buffing surface provided at the end. The draft gear to be tested is equipped with a dummy coupler shank having a flat face which is just

in contact with the buffing surface on the other pendulum, when both pendulums are hanging at rest.

The movement in either direction of both pendulums, and the movement of the coupler shank in the carrier iron, that is, the movement of the draft gear, in either direction, are to be accurately recorded by an oscillograph having a suitable time element, so that distance, velocity and acceleration at any point of swing or recoil can be determined. The records of the motions of the pendulum are obtained electrically from a contact point on each pendulum passing over a series of fixed contacts in the path of swing. The record of the motion of the draft gear is obtainable in a like manner through each 1/8 inch of travel by a contact on the dummy coupler shank passing over a series of fixed contacts in the carrier iron.

The pendulums are drawn back to the proper starting positions to give any desired speed, by motor-driven cables, fastened to the weights by hooks which can be released simultaneously by one electric key. The same key which releases these hooks starts the motion of the oscillograph.

Theoretically the difference between the sum of the travels of the pendulums from the point of release to the point of contact, and the sum of their recoils, will be a measure of the shock absorbed by the draft gear, and, therefore, of the efficiency of the draft gear. Thus, a draft gear having a low recoil would indicate a high absorption of shock and vice versa.

The pendulums are necessarily built-up weights, consisting of cast-iron segments, machined to a smooth fit, held together with tie bolts and the longitudinal framing to which the trunnions for the hangers are fastened. Provision has been made in the striking end to accommodate all the types of draft gears to be tested.

The committee regret that they have been unable to perfect the machine in time to have had a series of tests made during the past year, but expect to have the machine set up and make a series of tests of all kinds of friction draft gears now on the market, submitting a complete report at the convention of the year 1911, on the efficiency of friction draft gears.

There was no discussion of the report which was accepted and referred to letter ballot.

FREIGHT CAR TRUCKS.

Committee:—A. Stewart, Chairman; J. J. Tatum, A. S. Vogt, J. F. DeVoy and G. A. Hancock.

The subjects relating to freight car trucks, which the committee have had under consideration, are as follows:

To investigate and submit recommendations as to what changes in limits of axles are necessary to make them suitable for cars of 65,000 and 90,000 pounds capacity.

To reconcile the discrepancies existing between the measurement of the wheel seat of axle "B," on Sheet M. C. B. 7, and the condemning limits shown in Rule 23 of the Rules of Interchange.

To consider whether any revision of the present specifications for steel axles is necessary.

To consider whether any revision of the drop test for iron axles is necessary.

We are of the opinion that no intermediate sizes of axles differing from the "A," "B," "C" and "D" standards of the M. C. B. Association should be recommended. These standards have been so universally adopted in the States and Canada that it is the opinion of the committee that axles designed for the small difference in capacity suggested would only lead to confusion.

The second subject is a matter that involves discrepancies between the first and second tables under this rule, the first table having been inherited from the old rules in existence before the axles were redesigned and put in their present form. The second table under this rule, where the diameters are given in connection with maximum weights, was prepared following the method for calculating diameters of axles recommended by a committee in 1896. This was done with the idea that the practice of marking maximum weights would replace the marking by capacity, and is considered necessary for certain classes of cars, such as tank cars, etc. If the diameters given in the first table, which refer to capacity of the car, were brought up to correspond to those in the second table, it would result in a large number of the older equipment being refused at interchange points. For this reason, it is the opinion of the committee that Rule 23 should remain as at present.

Since the original specifications for steel axles were compiled and worked up, considerable data has been accumulated, not only from the service of the axles, which, as far as we can ascertain, have been exceedingly satisfactory, but by the steelmakers, who are offering data of various kinds, which indicates that a change in the composition of the steel will possibly be advisable to still further improve the axle. This refers particularly to the introduction of a higher percentage of silicon, which a few years ago was seriously objected to on account of manufacturing difficulties. However, in recent revolution tests, it appears the addition of silicon has doubled and in some cases quadrupled the life of the specimen under standard conditions of tests. This work is being continued, and probably in another year will be completed, but at present the committee is of the opinion that it would be unwise to make any change in the present axle specifications.

It seems the original committee which drew up the existing specifications for iron axles was quite aware of the fact that, so far as deflections under the drop tests were concerned, it was doubtful whether iron axles would meet the specifications, and it seems to have been its idea to discourage their manufacture. As proper wrought-iron scrap, suitable for the manufacture of axles, is becoming more and more difficult to obtain, and fewer of them are used each year, it is the opinion of the committee that no changes should be recommended in the present specifications.

There was no discussion or action on this report.

SALT-WATER DRIPPINGS FROM REFRIGERATOR CARS

Committee:—M. K. Barnum, Chairman; G. W. Lillie, W. E. Sharp, E. W. Pratt, D. C. Ross, W. C. Arp, P. Maher.

The committee made a series of tests during the hot weather of last summer, the results of which are plotted on the chart, Fig. 1 (not reproduced). These tests justify the committee in making the following recommendations:

All salt-water drippings should be retained in the ice tanks and drained off only at icing stations.

The total capacity of drain openings should not exceed the capacity of traps, and the capacity of both drains and traps should be sufficient to release all drippings within the time limit of icing the train.

The mechanism adopted for handling drain valves should be simple and positive, and so designed as to insure closing the valves before hatch plugs can be returned to their places.

Salt drippings should be conducted from ice tanks through the drain valves above described and thence to the outside of cars through the regular traps and drain pipes.

The packing companies have co-operated with the committee in their investigation, and have expressed their willingness to put into effect the practice recommended by your committee, if these recommendations meet with the approval of the Master Car Builders' Association.

In addition to the subject of "Salt-water Drippings," the Secretary of this Association has turned over to the committee correspondence from the Railroad Refrigerator Service Association, suggesting the following questions:

1. The uniform height of refrigerator cars from the rail to the floor.
2. The adoption of a standard drip cup for refrigerators.
3. Relatively small ice tanks.

The Railroad Refrigerator Service Association has not presented sufficient data to show the necessity for special action on these subjects, and the amount of information which the committee has been able to obtain indicates that any difficulties which may have been experienced from these features of refrigerator cars are due rather to old designs than to prevailing practice.

Therefore, if it is the desire of this Association to have these questions investigated, we would recommend either that a special committee be appointed for the purpose, or, if preferred, that the present Committee on Salt-water Drippings be continued for the work.

Discussion—The report was highly complimented, and Mr. Pratt reported the very gratifying co-operation of the private car owners who posses about 99 per cent. of the cars of this kind.

Action—Referred to letter ballot, committee discharged.

REPORT OF COMMITTEE ON CONSOLIDATION.

MEMBERS OF COMMITTEES.

American Railway Master Mechanics' Association.—D. F. Crawford, H. H. Vaughan, G. W. Wildin.

Master Car Builders' Association.—F. H. Clark, W. A. Nettleton, C. A. Schroyer.

Apart from any legal questions, it may be, we consider, granted that neither the Master Car Builders' nor the Master Mechanics' Association would agree to being absorbed by the other. Both have a long and honorable history. Founded in 1867 and 1868, respectively, each has accomplished magnificent results in the investigation of the multitude of problems that have arisen in the gradual development of American railway rolling stock, and in the determination of national practice in design and operation. Both are to-day progressive and successful. There is no question of either needing the assistance of the other to ensure its continuation or development. They stand as pre-eminent examples of voluntary associations of men employed by the railway companies of the country who have labored and studied for the benefit of those companies as a whole.

Such being the case, if it be decided that, for the benefit and

convenience of the members of these associations, it is advisable that their work be continued by one united society in place of two separate ones, the only feasible plan would be to form a new association to take the place of the two older ones, and independently and voluntarily terminate their existence. The legal questions involved in such proceedings require investigation, and it is possible that technically some different arrangements would have to be made. This is not, however, material, and we assume that the question for discussion is not that of absorption or consolidation, but the formation of a new and united association, which, including in its members employees of both the car and locomotive departments of our railways, may be called The American Railway Mechanical Association.

A change of this kind is important and should, we believe, if carried out, be only made after the most careful consideration. There are, no doubt, however, powerful reasons in favor of such a movement; reasons which have developed from the change which has taken place in the organization of the mechanical departments of the railway companies themselves during the existence of the two associations.

The appointment of a joint official in charge of both car and locomotive departments has led to the same men being largely in charge of the design, construction and maintenance of both cars and locomotives. The consequence is that men are attending the Master Car Builders' Association in connection with car matters, and the Master Mechanics' Association in connection with locomotive matters. To a great extent, therefore, the reasons that previously existed for the maintenance of two separate associations have been gradually removed. There is, no doubt, still a considerable feeling in favor of their retention, and it was voiced very clearly by President McKenna in his address to the Master Car Builders' Association last year.*

Mr. McKenna's remarks undoubtedly require the most careful consideration. They may be regarded not only as a personal opinion, but as expressing that of a large proportion of the membership of the association over which he presided. They describe the Master Car Builders' and Master Mechanics' Association as having separate and distinct fields of action; the Master Mechanics' as being technical in its nature, while the Master Car Builders' has rather that of a legislative body. There is, no doubt, a great deal of truth in these distinctions, and yet it is questionable whether they do not refer rather to conditions existent in the past than those of to-day. The legislative nature of the Master Car Builders' Association is entirely caused by the successful action of a voluntary association in organizing the rules governing the interchange of equipment between the railway companies of the country. These rules have been so wisely drawn and fairly administered that, without any direct powers having been granted to the associations by the railway companies officially, their accedance has in practically all cases been obtained, and the Master Car Builders' Association is to-day recognized as the organization empowered to formulate regulations required to enable the transfer of cars from road to road with the greatest dispatch consistent with the respective interest of owner and user. This has been but one part, however, of the work of the Association, although it has been so well done that it has secured the admiration and endorsement of all railway managements and has led to this being regarded, perhaps, as its greatest field of usefulness. The other, and equally important, part has been that of a great technical society specializing on subjects connected with the car department and thus supplementing the work of the Master Mechanics in the locomotive field. The subjects being investigated by committees this year are, with the exception of those pertaining to the interchange of cars, just as much the work of a technical association as are those in the Master Mechanics' Association. The condition actually is that two large enginering societies are in existence: the one investigating matters connected with the design, construction and maintenance of locomotives, the other with similar subjects for cars, while the latter at the same time determines the rules governing the interchange of equipment.

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The conclusion is evident that the distinction between the work of the two associations is only in kind. It is not a distinction that necessitates the employment of different men with different training, belonging to different departments of the railways. Each is engaged in a portion of the work of the mechanical department, with the same men in charge, interested in the subjects discussed in each and bearing their share of the investigations and experiments in both.

It is difficult, therefore, to-day, to justify the continuation of two separate associations on the ground of the difference in their fields of work or the variation in their memberships. The strongest opposition to such a change is in the statement made by Mr. McKenna: "Unless improvement is possible, change should not be favored." Apart from any question of sentiment, it is a serious matter to disturb the successful operation of over forty years. The question for consideration is really whether the attendant advantages are sufficient to justify the change. The most important is the possible saving in time. Under the present arrangements, to attend the first convention means, for the majority of our members, that they must leave home on the Monday or Tuesday night, and, if they stay for the second, they cannot return until the Thursday or Friday of the succeeding week. Practically, therefore, attendance at both conventions means that two weeks must be given up to the work, and, under present conditions, this is frequently more than can be spared, important as these conventions are recognized to be.

The existence of one executive committee in place of two would reduce the demands on the time of the men enaged in carrying on the business of the associations, and would facilitate the work of selecting subjects for investigation by committees and the names of the members composing them. Under present conditions, it is practically necessary to hold the meetings of the two executive committees either jointly or in communication with each other, both for this purpose and for business connected with the carrying out of the convention arrangements. One executive committee would be more efficient in handling any matters connected with both car and locomotive departments than are two, and, if selected from various sections of the country, would form a strong and representative body for any work in which their services might be of use.

The discussion of similar subjects in two associations would be done away with. Apart from the committees on Consolidation and Arrangements, there are to-day three subjects, Safety Appliances, Lumber Specifications and Train Brake and Signal Equipment, which are being investigated by committees from both associations. In two cases the membership of the committees is practically the same, a recognition by the executive committees of the desirability of reducing as much as possible the time demanded from our members in carrying on this work. There are other subjects on which committees have been appointed on which joint action would logically be required, were it not for the recognition of the unnecessary work involved in considering the same subject in both conventions. The time has largely passed when one practice obtained in the car and another in the locomotive department unless there is a good and valid reason for the difference. The agreement on a uniform practice, if possible, or the accceptance of a reason for divergence, can be far better discussed in one association than in two, apart from the saving in the time of the members of the committees, the duplication of reports and experiments.

In a joint convention the time allotted to the various subjects could be better allotted than when the two are separate. The work in each varies from year to year, and, while, no doubt, it has a tendency to increase, there is sometimes a question whether the investigation of a subject is not carried out in order to arouse interest in the convention, rather than on account of its pressing necessity. With one executive committee the subjects could be determined on with less reference to the time at disposal and with more consideration to their relative importance. It would also be possible and advantageous to avoid the tendency to hurry the discussion on what may have proved to be a more important and contentious subject than was anticipated, which now frequently occurs in order to enable the programme to be completed on time. With double the time at their disposal, the meeting could give each subject the attention it requires, and gain on a subject which did not develop the expected discussion the additional time occupied on one which exceeded expectations.

The committee was not instructed to draw any conclusions as to the desirability or otherwise of forming a new association, and has intended to present the arguments for and against that course. It was also instructed to prepare a constitution for a new association, and considers that one modeled after that adopted by the Master Car Builders' Association last year, with certain modifications to render it applicable to a joint association, would be most suitable. It is appended.

Discussion—This subject brought out the liveliest discussion of the whole convention. A number of arguments were advanced against any consolidation of the two associations. Among these was one from Geo. L. Fowler, who thought that to combine all of the work into one week of continuous sessions would decrease the efficiency of the members at the later sessions. Mr. Schroyer mentioned the possibility of there being little time available to study the exhibits if the conventions were held within a single week.

Opposed to these ideas were Mr. Wilden, Mr. Gaines and Mr. Vaughan. The latter, as a member of the committee, presented the whole matter in a very clear-cut way, saying in part:

"The only way we can look at this matter is that the consolidation of the car and locomotive departments under one heading has already been effected on the majority of railroads. The question of the advisability of that consolidation is one that we

* See AMERICAN ENGINEER, July, 1909, page 289.

did not consider; we have to take things as they are and not as we might like them to be.

"I am not by any means prepared to advocate the advisability of the consolidation of the car and locomotive departments. I do not think that is the question at issue. The chief question is, whatever our opinions of the matter may be, that on the majority of roads the car and locomotive departments are under the charge of a mechanical officer. They are two different departments, it is true, but they are under one general superintendent. We have to admit, from the facts which exist, that a large majority of the railroad companies have felt that to be the advisable method. It seems to me that the general feeling of a railroad executive is that he wants a mechanical officer to look to for the direction of both car and locomotive matters. He has his operating man on operating matters, his accounting man on accounting matters, a chief engineer on permanent way matters, and the chief executive of a railroad wants his mechanical man on car and locomotive matters; in other words, on most of the railroads of this country a mechanical department has been organized, and the car and locomotive departments have been merged into and combined in it.

"Mr. Wildin has called your attention to the fact that we have mostly locomotive men on a great many of the committees of this association. I do not like that way of putting it. I must disagree with Mr. Wildin. I would say that the mechanical department is represented by a large number of men on the committees of the M. C. B. Association, and that a large number of the same men are on the committees of the M. M. Association. I also call your attention to the fact that your presidents and vice-presidents are men equally eligible to be officers of either the M. C. B. Association or the M. M. Association, and to a large extent the same men are interested to-day in both organizations. As Mr. Hennessey said, the car department is the department on the railroad that entails the expenditure of the most money. I do not think there are any railroads concerning which this is not true, and the consequence is that the officer in charge of the mechanical department of the railroad is practically compelled to attend the meetings of the M. C. B. Association on account of the large amount of interest he has in its meetings. He may have been a car man originally, or he may have been a locomotive man originally, through whichever line he has come up, he is obliged to take a deep interest in the convention of the M. C. B. Association because the proceedings of that association affect his road to such a vital extent.

"I cannot but feel that the tendency has been for the meetings of the M. M. Association during the past few years to suffer from the fact that mechanical officers have been called upon to attend the M. C. B. Association on account of the importance of the subjects discussed at its meetings, and also on account of the spreading out of the time occupied by these two associations. It has been a quite frequent occurrence that these men have been obliged to go home, after attending the meeting of the M. C. B. Association, and neglect the meeting of the other association.

"My feeling very keenly is that the M. M. Association is the one that needs this consolidation more than the M. C. B. Association. The M. C. B. Association has an amount of business interest to the railroads that compels the attendance of the mechanical department officers, while the M. M. Association, being more technical in its character, naturally suffers through the lack of attendance of these representatives and their failure to take the same interest in its proceedings which they take in the proceedings of the other association.

"As far as the question of time is concerned, I do not want to paint any picture of how good an association we might have, or how much time would be saved, but I do feel that one association would be stronger and would have certain advantages over two. I do not think we would be straining beyond the breaking point by attending a convention in one week, instead of spreading it over two weeks, or what practically amounts to two weeks. It seems to me, if the associations were consolidated, that the man who is chiefly interested in locomotive subjects would stroll out and have a look at the exhibits while the question of the splicing of sills was being considered in the convention. On the other hand, the car man might not be interested in the question of superheat for the locomotive, and while that subject is being discussed he would have an opportunity to look at the exhibits. I firmly believe that the attendance at the exhibits would be improved by holding the convention within the period of one week.

"It is a question in my mind as to whether the vote of the membership as a whole is constitutional, whether an amendment to the constitution would not have to be introduced to make such a vote effective. I must confess that I do not understand the legal standing of the M. C. B. Association, and I do not know that anybody else does. All these questions will have to be considered. My feeling, personally, is that Mr. Schroyer's motion is an exceedingly wise one, and it is exactly what should be done with this report—action on it should be delayed for a year to give everybody a good chance to think it over and come to some conclusion about it. It is too serious a thing to jump into without proper study. The committee never desired any such action as would bring the consolidation about rapidly. All we expected was that the matter would be carefully considered, and carried along for a year or two, so that everybody interested could have a full and unlimited opportunity to thresh it over and see whether or not such a thing was desirable.

"I believe we should add to Mr. Schroyer's motion, that the matter should be laid over for a year and, also, that it should be referred to the executive committee for further report and consideration, so that the committee may be in position to look up the legal questions concerning which, owing to a good many delays, we were unable to obtain any information. They might also look up the action that could be taken if a consolidation is deemed desirable. I think that is a matter for the executive committee to deal with. We were unable to do it on account of the delays in getting the consensus of opinion of the various members of the executive committee, and there again is an instance of the desirability of one good, strong executive committee. We took quite a lot of time in securing the consent of the executive committees of the two associations in order to procure authority to secure legal advice in the matter."

Action—The motion that the subject be laid on the table for another year, that the executive committee of the association be instructed to consider the legal and other aspects necessary to put the matter through, and that the members be given an opportunity to further consider the matter was carried.

TANK CARS.

Committee:—A. W. Gibbs, Chairman; C. M. Bloxham, S. K. Dickerson, J. W. Fogg.

In the report of the committee to the last convention, attention was directed to tank cars constructed without side sills, on which no means are provided for jacking to facilitate handling in derailment and repairs.

In order to determine the necessity for these jacking castings, tests were made with a loaded tank car, limit weight 132,000 pounds, fitted with continuous center sills, but no side sills, and not equipped with jacking castings; also with a loaded tank car, limit weight 132,000 pounds, constructed with reinforced shell, having no center sills or side sills, and not equipped with jacking castings.

In addition to these tests made by the committee as a whole, the individual members of the committee looked into the matter at their home shops, and, while they found comparatively few cases where it was necessary to jack loaded cars, not equipped with side sills, for the removal of wheels and still a lesser number for the removal of trucks, the consensus of opinion is that jacking castings are desirable to promote safety in doing the work, aside from the question of additional labor involved when these cars are not equipped with suitable jacking castings. The most suitable location would seem to be at the body bolster.

Inasmuch as there are freight cars of other types in service which should also be provided with suitable jacking castings, on account of the present difficulty experienced in jacking up cars not equipped with side sills of sufficient section to withstand the pressure of the head of the jack, this question becomes one of general importance, and the committee would, therefore, recommend that a special committee be appointed to go into this ques-

tion generally, so that any Recommended Practice adopted will cover the whole situation.

With this question eliminated, the work of the Tank Car Committee is practically concluded, and, as the provisions of the Tank Car Requirements have now been Recommended Practice for a number of years, the committee would recommend that the present Recommended Practice be advanced to Standard and the committee discharged.

Inasmuch as the various railroads are now printing their own tank-car circulars, we think it would be advisable for the M. C. B. Association to have them printed in pamphlet form, so that they can be purchased by the various members at a nominal sum, the same as the Interchange Rules and the Loading Rules.

It was voted to submit the present recommended practice for tank cars to letter ballot for adoption as a standard.

TRAIN BRAKE AND SIGNAL EQUIPMENT.

I.—LAKE SHORE EMERGENCY BRAKE TESTS.

Committee:—A. J. Cota, Chairman, F. H. Scheffer, R. K. Reading, E. W. Pratt, R. B. Kendig, T. L. Burton, B. P. Flory.

Representatives from several railroad companies having under construction heavy steel passenger equipment cars proposed to the executive committee of this Association, during its convention last year, a subject requiring the immediate consideration of the Committee on Train Brake and Train Signal Equipment, namely, *The definition of proper air-brake equipment for passenger cars weighing 130,000 pounds or over."*

The Committee on Train Brakes and Signal Equipment was accordingly summoned to attend a joint meeting of the committee and representatives from various railroad companies and manufacturers directly interested in the subject, at the Union Station, Pittsburg, July 1, 1909.

There were present at this meeting representatives from the Pennsylvania Railroad System, New York Central Lines, Baltimore & Ohio Railroad, Pullman Company, American Brake Shoe & Foundry Company, American Brake Company and Westinghouse Air Brake Company. Other brake manufacturers were requested to have representatives present, but failed to do so.

A. W. Gibbs, G. S. M. P., Penna. R. R. Co., was elected chairman of the meeting. The object of the meeting was, on the request of the chairman, explained by Mr. A. L. Humphrey, in effect that some hundreds of passenger cars contracted for early delivery would be of such weight as to have practically outgrown the foundation brake rigging of to-day, and a radically new design was imperative. However, it would be too late for consideration after the next Master Car Builders' convention. The heavy cars contracted for would soon be delivered and brake designs must be decided upon at once. It was further brought out that until five years ago the maximum weight of cars approximated 90,000 to 110,000 pounds, and with such cars it was found necessary to employ 16-inch or 18-inch brake cylinders. The leverage ratio used was as high as 9 to 1, which is the recognized maximum ratio of leverage permissible; the 18-inch cylinder would provide for cars of maximum weight up to 127,000 pounds. For cars above this weight it will be necessary to increase either the leverage ratio or the cylinder power. Cars now under construction will weigh from 140,000 to 150,000 pounds and even more, which makes it necessary to redesign foundation brake rigging so as to provide a suitable brake.

Manufacturers could probably meet the conditions by employing a 20-inch brake cylinder. This, however, is very objectionable from many standpoints. It would involve the question of clearance space underneath the car, severe horizontal stresses in car body members, increased cylinder leakage, it being quite impossible to obtain packing leathers of sufficient uniformity to prevent excessive leakage, and the pistons, rods and lever would become so heavy that it would require some fifteen or twenty per cent. of the brake power to move them. It was felt, therefore, that the 20-inch brake cylinder is impracticable.

If not a 20-inch cylinder, it would necessarily call for two cylinders of an approximate equal area, say two 14-inch cylinders, one on each end of car. This would mean a complication in the way of double equipments, which should receive careful consideration on the part of the Master Car Builders' committee and railroad representatives present. It would also be quite difficult to operate the two equipments with one triple valve.

Another proposition would be to place the entire apparatus on the trucks, using either a single or two cylinders of equal area, which method, if considered desirable, would require flexible connection between the brake pipe and the cylinders.

Another method would be to use the clasp brake, requiring two brake beams or four shoes to each pair of wheels. There are, however, many objections to this design also, and it is very questionable whether the acknowledged theoretical advantages of the clasp brake would be considered practicable.

Another scheme would be to permit an increase of piston travel by lengthening the brake cylinder. This is also objectionable on account of the undesirable angularity of levers thus involved.

The matter can, therefore, be resolved into five propositions, as follows:

1. A 20-inch diameter brake cylinder, with increased packing leakage.
2. Two brake cylinders per car, which would probably make it necessary to provide two complete brake equipments, including triple valves, etc., whether applied to the car body or trucks.
3. Clasp brakes, meaning the application of two brake shoes per wheel, one on either side. This method would probably provide ample braking power for a 150,000-pound car using an 18-inch diameter brake cylinder, with a leverage ratio of 9 to 1.
4. Increased length of an 18-inch brake cylinder, and consequent longer piston travel, with an increased leverage ratio and objectionable angularity of levers.
5. Two brake cylinders of equivalent area to one 20-inch cylinder applied one to each truck.

Further discussion of the subject proved it to be a quite live one. The demands for heavy high-speed passenger service have developed a class of equipment, whether of steel or of composite steel and wood construction, whose requirements demand unit weights of cars far in excess of that required even five years ago.

The brake apparatus has not kept pace with the increased weights and speed of the modern passenger train. Contributing factors which make necessary a different treatment in the application of braking or retarding force than that heretofore practiced are, briefly:

1. Increased unbraked locomotive weight.
2. Increased train momentum.
3. Increased brake rigging deflection and false motion, due to severe stresses in car members and other causes, which greatly increase the piston travel.
4. Increased brake leverage ratio, with consequent increased piston travel and lower maximum cylinder pressure.
5. Increased time to obtain brake effectiveness, on account of large cylinder volumes.
6. Decreased brake shoe coefficient of friction, due to greater brake shoe pressures and speeds.
7. Possible breaking down of the brake shoe under the severe conditions imposed.

It was the sense of the meeting that the problem should at once be considered from both a practicable and theoretical standpoint, and accordingly a sub-committee, composed of Mr. A. J. Cota, T. L. Burton and D. F. Crawford, was appointed, to determine the scope of and establish a basis for the investigation. The following resolutions, as submitted by this committee, were unanimously adopted by vote of the railroad representatives present:

"Resolved, That it is the sense of this meeting that the air brakes provided for the heavier passenger cars now building shall be of such design, proportion and capacity as to enable trains of the said heavier passenger cars to be stopped in practically the same distance after the brakes are applied as is now the case with existing lighter cars; and be it further

"Resolved, That for the use of this committee and others interested in making calculations, we suggest that it be assumed that the theoretically desirable stop is one which required the space of not over 1,200 feet after the brakes are applied, the speed of the trains at the time of the application of the brakes being sixty miles per hour."

Another sub-committee was then appointed, composed of Messrs. W. F. Keisel, Jr., R. B. Kendig, C. S. Knapp, W. V. Turner and F. W. Sargent, to make recommendation as to the maximum load per brake shoe, from which figure would be calculated the percentage of retardation necessary and also to make recommendations as to the number of shoes per car for different weight of cars.

The sub-committee was continued for a meeting of the representative committee, at which time they were to report on the following questions:

1. Allowable pressure per shoe.
2. Arrangement of cylinders and number of shoes for eight-wheel cars weighing 90,000 pounds and over.
3. Arrangement of cylinders and number of shoes for twelve-wheel cars weighing 120,000 pounds and over.
4. Recommendations as to limit of capacity and deflection of brake beams where used on above cars.
5. Recommendations as to arrangement of hand brakes.

A brief synopsis of their report follows:

1. F. W. Sargent, chief engineer of the American Brake Shoe & Foundry Company, assisted by R. C. Augur, then of the Westinghouse Air Brake Company, made a number of tests at the former company's laboratory, Mahwah, N. J., for the purpose of determining the mean coefficient of friction between wheel and shoe with M. C. B. Standard dimensions for plain and chilled cast-iron shoes. The results of the tests indicated that the mean coefficient of friction as high as 10 per cent. could probably be realized in service.

Based on these tests, it was the opinion of the committee that the maximum pressure per shoe should be set at 18,000 pounds,

or 400 pounds per square inch, and that in no case should these pressures be exceeded.

2. It was agreed that the stop distance should be measured from the point where brake application is made, and that allowance would, therefore, have to be made in the calculations by deduction from the length of stop for the lapsed time before the brake became effective, estimated at two seconds, or a traveled distance of 176 feet, at the initial speed of sixty miles per hour.

3. In order to determine a basis on which to consider the brake power of the cars themselves, an ideal train, consisting of one locomotive and six cars was selected. It was agreed that the total weight of cars in the ideal train should be considered as being twice the weight of locomotive and tender. In other words, the weight of locomotive and tender should be one-third the weight of the entire train. Previous tests seemed to indicate that the effectiveness of brake on locomotive and tender is decidedly less than on cars. In some previous tests, when engine was disconnected immediately before brake application, the distance in which the locomotive came to a stop was nearly twice the distance in which cars stopped. It was decided, therefore, to class the effectiveness of locomotive and tender brake at one-half that of the cars. Taking the car effectiveness at 100 per cent. and the locomotive at 50 per cent., and assuming the train composed of three unit weights, the brake effect of the ideal train would be in the ratio of 250 to 300, or as 5 to 6, as compared with the 100 per cent. effectiveness of the cars. It was assumed, therefore, that a greater car retarding force would be necessary in the proportion of 6 to 5 than that necessary to stop the cars alone in that distance.

4. A further increase in the retarding factor for the cars is required to compensate for the load on cars, which was estimated as 7 per cent. of the light weight of train. It was thought advisable to apportion this load over the train as follows:

Sleeping cars, 3 per cent. of light weight of cars.
Coaches, 10 per cent. of light weight of cars.
Load cars, 15 per cent. of light weight of cars.

5. With the foregoing data and assumptions determined, the required retarding force in terms of weight of car could be found as follows:

F = retarding force.
s = desired length of stop in feet.
w = weight of car.
V = velocity in feet per second.

(1) $S = \frac{5(s-2V)}{6}$ = compensated length of stop in feet, allowing for elapsed time to brake effectiveness, and also for the effect of the unbraked weight of locomotive.

l = lading allowance to be added to w,
.03w for sleeping cars,
.10w for coaches,
.15w for load cars.

(2) $W = w + l$.

g = acceleration of gravity = 32.2.

Then for the work to be done,

(3) $FS = \text{work} = \frac{1}{2}MV^2$, and where $M = \frac{W}{g}$

(4) $F = \frac{W V^2}{2 g S}$

6. The coefficient of friction of the brake shoe against wheel was decided as 10 per cent. The efficiency of the brake rigging was assumed from previous tests to be 85 per cent.

For cars equipped with brake beams the ratio of maximum cylinder pressure to maximum shoe pressure should not exceed 9; for cars without brake beams this ratio should not exceed 9.63; the maximum shoe pressure to be 18,000 pounds, as previously stated.

Based on these figures, the maximum car weight for single shoe per wheel could be determined from the formula.

If brake beam release springs or other devices materially affecting the efficiency of the brake gear are used, suitable allowance should be made.

7. It was recommended that brake beams used on these cars should not deflect more than 1-16 inch under maximum emergency brake load, and that such brake beam should not take a permanent set under a load of 50 per cent. in excess of the emergency brake load.

8. It was recommended that the hand brakes should be so connected that neither the cylinder nor hand-brake rod should act as a fulcrum for the other; also that the slack adjuster should be so located that it adjusts both air brake and hand brake equally; that there should be room for at least 30 inches, preferably 36 inches, of chain on each shaft, or worm, of the winding apparatus, with 3,000 pounds pull on the hand-brake rod; that a release spring should be attached to the hand-brake lever to release the hand brake and prevent excessive sagging of the chain; that cars which are equipped with two cylinders have the hand brakes at the two ends of car arrranged to operate independently of each other, and that each should apply the brake on one truck only.

With two cylinders per car, both cylinders should be attached to car body.

9. As there seems to be a possibility of pushing the axle out of its bearing, on account of high brake power, this question was taken into consideration. The committee recommended that the resultant of static load and brake-shoe pressure on axle be determined, and that the direction of this resultant be kept inside of a line through center of axle and edge of bearing to an amount equal to 10 degrees. Other forces also act at this point, such as brake hanger effect on truck frame and friction between journal and bearing. If careful estimate of direction of resultants, based on all forces acting on the journal, is made, it would seem sufficient to have the direction of this resultant, when passing through center of axle, 5 degrees inside of the line throught center of axle and edge of bearing. The direction of the resultant may be varied by lowering the brake shoe. It was further considered that, on account of the high brake effect on passenger cars, the strain on the axle would be greater than on the same axle in freight service. The minimum resultant of static load, and brake pressure in freight cars, had been estimated at 125 per cent. of static load. For passenger cars the minimum resultant was estimated at 187.5 per cent. of static load, or 50 per cent. greater than in freight service. Passenger cars, however, have a lower center of gravity than that taken for freight cars, which has a tendency to reduce the strain per journal. Axles are also less subject to shock in passenger service than in freight service, for which reason it did not seem necessary to make an allowance commensurate with this condition. This indicated that it was not advisable to make an arbitrary reduction in axle capacity under static load for passenger service, without a more careful investigation than possible in the limited time at command. Since the axle capacity is not a function of the brake design, this subject can be held in abeyance until the various railroads can look into the question fully and give their recommendations.

Discussion following the reading of report resulted in a consensus of opinion that before acceptance of the recommendations offered a demonstration should be made by actual road tests with trains such as considered, during which tests records should be taken of all items of interest and particularly those representing the basis for calculating lengths of stop.

The programme decided upon for the trials contemplated the following comparisons:

1ST—TRAIN CONSISTS.

a. Two locomotives and ten twelve-wheel cars.
b. One locomotive and ten twelve-wheel cars.
c. Two locomotives and six twelve-wheel cars.
d. One locomotive and six twelve-wheel cars.
e. One locomotive and six eight-wheel cars.

Dynamometer car to be used in several runs to measure the unbraked locomotive effect.

2D—SPEEDS.

a. Sixty miles per hour.
b. Eighty miles per hour.

3D—BRAKE EQUIPMENT.

Twelve-wheel Cars.

a. High-speed brake, 90 per cent. of weight of car, based on 60 pounds cylinder pressure. With maximum cylinder pressure, 85 pounds equals 127.5 per cent.

b. Retarding percentages as recommended by committee, with cylinder pressure 105 pounds. Note that, as explained in committee's report, this force varies for different classes of cars.

Eight-wheel Cars.

c. High-speed brake, 80 per cent. of weight of car, based on 60 pounds cylinder pressure. With maximum 85 pounds cylinder pressure equals 113.3 per cent.

d. The same brake leverage at 105 pounds cylinder pressure, which is equivalent to 140 per cent. braking power.

4TH—BRAKE SHOES.

a. Chilled cast-iron shoes.
b. Plain cast-iron shoes.
c. Experimental, or even proprietary brake shoes, if necessary, on account of the possible breaking down of the cast-iron shoes under the enormous test pressures proposed.

The American Brake Shoe & Foundry Company offered to furnish the necessary brake shoes required for the tests, which offer was also accepted.

The brake shoes requested for test were as follows:

1. Plain cast-iron, to P. R. R. specification.
2. Chilled end cast iron, commonly known as the "U" shoe, as used on the New York Central Lines.
3. Chillled inset cast iron, Streeter type, as commonly used on a number of roads.
4. Composite steel and cast iron, commonly known as Diamond S, also used by a number of railroads.

The above types of brake shoes were considered as fairly representing the types commonly used in passenger service throughout the country. In addition, the brake shoe company was requested to furnish another type, if possible, having a greater mean coefficient of friction, considering the service, than those mentioned above; this type was not named, and will be classed simply as "Experimental."

A stretch of ground, with stopping ground, two miles west of Milbury Junction, on the main line of the Lake Shore & Michigan Southern Railway, was selected for the test. This selection was

made with the idea of obtaining a perfectly level stopping ground at a point on the road where the passenger train schedule permitted the use of a high-speed testing track for considerable time during the day, without interfering with the regular passenger traffic. There are four tracks between Milbury and Toledo, which permitted the freight movement, uninterrupted, on the outside tracks.

An old box-car body was set off at the stopping ground and fitted up as a cabin, in which were installed the chronograph outfit for recording the succcessive speeds of train during the stop, telegraph instruments for following the movement of the test train, telephone for communication along the test ground, and drawing-tables, at which were worked up daily, for distribution to members of the crew and visitors, a complete log, showing the results of the runs made the previous day.

Circuit-breakers arrranged to record the movement of the test train were located along the track at equal intervals in electric communication with the chronograph. This enabled the speed of train over each 100-foot interval, after passing the trip, to be recorded. The trip consisted of a wedge-shaped obstruction outside the rail, which engaged a mechanism on the locomotive operating a cut-out cock, which in turn made an emergency application of the brake the instant the locomotive passed the trip. Circuit-breakers were also located back of the trip some distance, from which the speed at time of applying the brake could be accurately determined. A more complete description of the testing apparatus is given in the appendix (not reproduced).

The twelve-wheel cars (L. S. & M. S.) used in the test were equipped with the original foundation brake and apparatus as received from the car builders, being at that time the New York Central Lines' standard practice for that class of equipment. The apparatus was of the improved type, with supplementary reservoir to give 105 pounds emergency brake cylinder pressure at 110 pounds brake-pipe pressure, and for want of simpler description will be designated by the manufacturers' symbol, LN. The cylinder levers were changed to conform with the committee's recommendation for retardation at brake shoe. Additional apparatus was installed on each car, so that quick change could be made to the high-speed brake practice for comparison.

The normal weight of the car was approximately 126,000 pounds, and under the conditions laid down by the sub-committee this would not give the maximum permissible brake-shoe pressure. A pressure of 18,000 pounds per brake shoe was provided for, however, by loading one of the cars to 149,000 pounds; another was loaded to 140,000 pounds, as an intermediate step, and the remaining cars tested at normal weight.

The application of such force as 18,000 pounds to a brake shoe involved the design of a special brake beam, which was undertaken by a Cleveland concern, but in the limited time available only a sufficient number were secured to equip the two heavy cars; the remaining cars were equipped with the regular high-speed brake beams of the same general design, which was of the trussed type, having an angle-iron compressing member and round-bar tension member. The special brake beam tested at 49,000 pounds with 1-16-inch deflection, as against 30,000 pounds for the beams used on the normal weight cars. It appears, therefore, entirely feasible to obtain brake beams which will meet the specification requirement contained in the sub-committee report.

The eight-wheel cars used in the test were equipped for high-speed brake, but additional apparatus was supplied to make a quick change to 105 pounds brake cylinder pressure, using the same brake leverage. The normal weight of these cars was 116,000 pounds, some 10,000 pounds heavier than the allowable weight recommended by the committee; for eight-wheel cars one shoe per wheel, so that the recommended retarding force could not be applied without exceeding the proposed limit of brake-shoe pressure.

It is regretted that on account of the unfavorable track conditions approaching the testing ground (a slightly ascending grade, with a bad curve two miles east of the trip) a speed of eighty miles per hour was not attained. Runs above sixty miles per hour were made at maximum speed of the locomotive instead of the programme speed.

The test was started on October 19 and continued until December 12, 1909, during which time two hundred and fifty-four (254) runs were made, each and every one of which is recorded in the test log (8 sheets) which accompanies this report.

Mr. S. W. Dudley, assisted by Mr. A. H. Elliott and other engineers under the direction of the committee, made a most thorough study and analysis of the data obtained from the tests, and their report is submitted as an appendix to this report, for the benefit of those who wish to make a detail study of the results.

A meeting of the sub-committee was held to consider the results of the test as applying the assumptions on which their recommendations were based, and after reviewing the data as analyzed in the appendix to this report, the following modifications to their recommendations were agreed upon.

1. Allowable brake-shoe pressures recommended as 18,000 pounds per square inch. The result of the test seemed to indicate that under the test conditions a pressure of 18,000 pounds per shoe can be safely used, and this maximum shoe pressure will stand as originally recommended. Pressures as high as 26,000 pounds total, or over 500 pounds per square inch, were used at sixty miles per hour with all the brake shoes tested, with no apparent bad results, but when the stop was made at higher speeds it was noted that the plain cast-iron shoes would heat to a high degree, emitting molten metal, which deposited on the track, car trucks and body. The only positive indications, however, that the danger point had been reached was on run No. 328, Penna. cars with 20,700 pounds total, or 449 pounds per square inch, brake-shoe pressure, plain cast-iron shoes, speed 74.75 miles per hour. On this stop a veritable flame of molten metal from 12 to 18 inches long was emitted from each of the shoes, and a number of them were heated to a red heat in making this stop.

2. Brake cylinder leverage ratio recommended, 9 to 1. The results of the test seemed to indicate the ratio to be too high. On the L. S. & M. S. six-wheel truck cars the increase of running emergency piston travel over standing emergency piston travel was very noticeable, amounting to as much as 4 or 5 inches. The brake shoes are of necessity hung low on six-wheel trucks and the high braking power was sufficient to drag the shoes downward, imposing a force on the brake hangers sufficient to compress the equalizer springs solid. With 6-inch standing emergency piston travel there would be danger of the piston bottoming in the brake cylinders, especially after the cars had been in service some time, with boxes, pedestals, etc., worn sufficiently to produce additional false piston travel over that obtained in the tests. Car 824 was equipped with two cylinders, giving a cylinder leverage ratio of 5 to 1, and from a study of the performance of this car it is concluded that for this class of car, with brake-shoe centers at least 6 inches below center of wheel, a ratio of 6 to 1 should not be exceeded.

The Penna. R. R. four-wheel truck cars had brake shoes hung 1½ inches below the center line of wheel, and noting from the performance of these cars the lever ratio should not exceed 8 to 1. The recommendations would then stand:

Cars having brake shoes hung 0 to 2 inches below center line of wheel, lever ratio 8 to 1; 2 inches to 5 inches below, 7 to 1, and below 5 inches, 6 to 1.

3. Time from brake application to brake effectiveness assumed by the committee as two seconds. In explanation, this term was based on the retarding effect produced after full cylinder pressure is obtained, and is the lapsed time when, if the average force had been instantly applied, would produce the same effect. It will be noted that every second of time taken from this term would have the effect of actually shortening the stop by a distance corresponding to the velocity in feet per second at the time when brake valve was operated in emergency application. As previously stated, the brake apparatus available at the time of equipping the test trains was 18-inch cylinders on all cars.

(A) Westinghouse LN equipment, designed to obtain in emergency, by means of a supplementary reservoir, a brake-cylinder pressure of 100 pounds at 8-inch piston travel with 110 pounds brake-pipe pressure.

(B) Westinghouse high-speed brake equipment, designed to give with 8-inch travel and 110 pounds brake-pipe pressure a maximum pressure of 80 pounds, which gradually blows down to 60 pounds toward the end of stop.

The test indicated that with the LN equipment the lapsed time was 2½ seconds, and with the high-speed equipment 2¾ seconds. On account of excessive running emergency piston travel, however, but 95 pounds cylinder pressure was obtained with the LN equipment, instead of the 100 pounds expected. In order to obtain 105 pounds cylinder pressure with this equipment it was necessary to increase the brake-pipe pressure above 110 pounds.

Another triple valve was substituted for the LN triple valve, known as the LGN, with which it was expected to obtain 105 pounds emergency cylinder pressure with 110 pounds train-pipe pressure. This equipment used the same auxiliary reservoir and supplementary reservoir as the LN equipment, but obtained its higher pressure by first equalizing with the auxiliary reservoir, then closing the communication between cylinder and auxiliary reservoir and further equalizing with the supplementary reservoir. This equipment was deficient as to pressure obtained by about two pounds, on account of the long running emergency piston travel experienced. While the test was continued by increasing the brake-pipe pressure to give 105 pounds emergency cylinder pressure, under these conditions it could not be expected with 110 pounds brake-pipe pressure to make quite the same stop as in these tests. The lapsed time to brake effectiveness was the same with this equipment as with the LN—2½ seconds. It became evident at this stage of the trials that unless the time from brake application to effectiveness could be shortened there would be small likelihood of making the stop in the desired distance of 1,200 feet.

In order to meet this condition the Westinghouse Air Brake Company undertook the design of an equipment which dispenses with the use of triple valves, using instead a valve of the general

type of the distributing valve called a control valve. With this equipment larger pipes and ports between the air reservoirs and the brake cylinders can be used, thus materially shortening the time of obtaining maximum cylinder pressure. In the limited time available during the test they were able to design, build and install on the test train a complete experimental equipment of the type mentioned, and with this equipment the lapsed time between brake application to effectiveness was reduced to two seconds, which answered the requirements of the sub-committee, and with this equipment the desired stop was actually made.

4. Ratio of train weight to locomotive weight assumed by committee as 3 to 1. The six-car L. S. & M. S. train had a weight ratio train to locomotive, 3.04 to 1, and the P. R. R. train ratio to locomotive was 2.8 to 1. It is seen, therefore, that the previous assumption of the committee represented fair average train conditions and will stand as first recommended.

4-A. Relative effectiveness of locomotive brake to car brakes assumed by committee as 50 per cent. These tests indicate a much greater relative effectiveness of the locomotive brake which, as shown by the results of break-away runs, where the improved type of locomotive and car brakes were used, should be increased to 75 per cent., and that figure is now recommended.

4-B. Ratio of train to car-brake efficiency derived from previous assumption of committee by combining assumptions in paragraphs 4 and 4-A, which was originally 5-6. Combining the revised factors, paragraphs 4 and 4-A, a factor 11-12 is derived.

5. Efficiency of brake gear assumed by committee as 85 per cent. of the cylinder effect.

5-A. Coefficient of friction assumed by committee as 10 per cent.

5-B. The apparatus which the committee had available to determine the brake-gear efficiency was not of sufficient capacity to obtain satisfactory results with the heavy cars used in the test. Neither was apparatus available to determine the coefficient of friction. It was therefore necessary to combine these two factors by taking their product. With the committee's previous recommendations this factor is 85 per cent. times 10 per cent., or 8.5 per cent. From the data of the break-away tests with the improved equipment, it appears that not more than 7.5 per cent. was realized. This factor should, therefore, be changed accordingly.

6. Concerning the additional retarding force to compensate for loads as previously recommended—3 per cent. for sleeping-cars, 10 per cent. for coaches and 15 per cent. for load cars—it was thought advisable to modify this somewhat, to avoid complications in the maintenance of brake gear. The new recommendation would be to make no load allowance for sleeping-cars, coaches and other strictly passenger-carrying cars, except that the recommended retarding force would be considered as a minimum. For load cars an allowance of 15 per cent. additional retarding force is recommended, which is considered as the maximum.

Returning to the formulæ for retardation, the new assumptions make the following changes:

$$S = \frac{11(S-2V)}{12} \text{ instead of } 5\text{-}6\ (S-2V).$$

$l = 0$ for passenger-carrying cars.

$l = 15$ per cent. for load cars.

Then by the substitution of known values in equation (4), the revised retarding force becomes

$F = 12.8$ per cent. for passenger cars.

$F = 14.7$ per cent. for load cars.

One of the most interesting and instructive, if not the most important results of the test, was the determination, by means of the dynamometer car, of the loss in tractive effort due to brake shoes rubbing the wheels.

The ten-car, twelve-wheel car train, with dynamometer car between locomotive and cars with brake adjusted at 6-inch standing emergency piston travel, required a drawbar pull of 8,370 pounds at sixty miles per hour, and on the next run same train, but with brakes adjusted at 7-inch standing emergency piston travel and brake shoes pried free of the wheels, the drawbar pull was only 6,200 pounds at the identical speed, indicating a loss of 35 per cent. tractive effort on the train with brake shoes rubbing the wheels. These forces were the average forces apportioned to speed over one mile of the run, obtained by subtracting the calculated uniform accelerating force from the observed average dynamometer pull in each case, and this accelerating force was so small and practically uniform in both cases as to be negligible. The 6-inch piston travel in emergency would probably amount to 7-inch, or the maximum allowable, in service, so that on trains with heavy cars equipped with six-wheel trucks and a 9 to 1 and greater brake-leverage ratio, this loss is going on, day after day, on all our heavy, fast passenger trains. The recommendation of a 6 to 1 leverage, therefore, should be given consideration as the most rational method of correcting this great loss in tractive effort and corresponding waste of fuel. There are hundreds of cars running to-day wherein this saving can be effected and advantage of this knowledge should be taken.

From the revised assumption for cylinder leverage and brake-shoe coefficient of friction times brake efficiency, a new table follows, which gives the size of cylinders recommended by the committee for various weight cars above 100,000 lbs. and cylinder pressure 85 pounds per square inch.

PASSENGER-CARRYING CARS.
One brake shoe per wheel.
Brake shoes hung 5 inches and more below wheel centers.
Brake leverage, 6 to 1.
Two 16-inch cylinders, cars weighing 100,000 to 121,000 lbs.
Two 18-inch cylinders, cars weighing 121,000 to 154,000 lbs.
Brake shoes hung 2 to 5 inches below wheel centers.
Brake leverage, 7 to 1.
Two 18-inch cylinders, cars weighing 142,000 to 180,000 lbs.
Two 16-inch cylinders, cars weighing 109,000 to 142,000 lbs.
Two 14-inch cylinders, cars weighing 100,000 to 109,000 lbs.
Brake shoes hung 0 to 2 inches below wheel centers.
Brake leverage, 8 to 1.
Two 18-inch cylinders, cars weighing 162,000 to 205,000 lbs.
Two 16-inch cylinders, cars weighing 124,000 to 162,000 lbs.
Two 14-inch cylinders, cars weighing 100,000 to 124,000 lbs.
Limit of passenger-carrying cars, one shoe per wheel.
12-wheel cars ....149,000 lbs.
8-wheel cars ....100,000 lbs.

LOAD CARS.
One shoe per wheel.
Brake shoes hung 5 inches and more below wheel center.
Brake leverage, 6 to 1.
Two 18-inch cylinders, cars weighing 106,000 to 134,000 lbs.
Two 16-inch cylinders, cars weighing 100,000 to 106,000 lbs.
Brake shoes hung 2 to 5 inches below wheel centers.
Brake leverage, 7 to 1.
Two 18-inch cylinders, cars weighing 123,000 to 156,000 lbs.
Two 16-inch cylinders, cars weighing 100,000 to 123,000 lbs.
Brake shoes hung 0 to 2 inches below wheel centers.
Brake leverage, 8 to 1.
Two 18-inch cylinders, cars weighing 141,000 to 178,000 lbs.
Two 16-inch cylinders, cars weighing 108,000 to 141,000 lbs.
Two 14-inch cylinders, cars weighing 100,000 to 108,000 lbs.
Limit of load cars, one shoe per wheel.
12-wheel cars ....129,000 lbs.
8-wheel cars .... 86,000 lbs.

Undoubtedly more consideration will be given to the clasp brake (with two shoes per wheel) both on account of its reducing the number and size of cylinders, but also lessening the dimensions and weight of brake rigging.

II.—TESTS OF TRIPLE VALVES MADE BY MASTER CAR BUILDERS' COMMITTEE ON TRAIN BRAKE AND SIGNAL EQUIPMENT.

[Results from tests made at Purdue University on two new triple valves were given in the report but the committee did not feel that sufficient data had been obtained to justify it in recommending to the convention a new code of tests for triple valves.—Ed.]

Discussion—It was explained that the committee had no recommendation to make in connection with flanged shoes. Mr. Burton personally considered that there was no question but what the flange shoe materially increases the efficiency of the brake.

Mr. Devoy thought we were trying to stop the very heavy modern trains in too short a distance.

The committee was continued.

[Reports of committees with discussion and action thereon covering the following subjects will be given in the next issue: —Car wheels, train lighting and equipment, mounting pressures for various wheels and axles, train pipe and connection for steam heat, lumber specifications, splicing underframes, car framing, roofs and doors, brake shoes, design of axle to carry 50,000 *lbs.* —ED.]

INVERTED PINTSCH MANTLE LAMP.—Over 73,000 lamps, using inverted mantles, have been placed on cars since October 1, 1909, bringing the lamps in service up to the tremendous totals of 60,000 in North America; 69,000 in England; 101,000 in France; 202,000 in Germany, etc.

OFFICERS OF THE GENERAL FOREMEN'S ASSOCIATION.—C. H. Voges, C. C. C. & St. L., Bellefontaine, Ohio, Pres.; T. F. Griffin, C. C. C. & St. L., Indianapolis, Ind., first vice-president; J. A. Boyden, Erie, at Cleveland, Ohio, second vice-president; E. A. Murray, master mechanic of the C. & O., Lexington, Ky., third vice-president; H. D. Kelley, C. & N. W., Chicago, fourth vice-president; L. H. Bryan, D. & I. R., Two Harbors, Minn., secretary-treasurer. The following were elected members of the executive committee in addition to T. J. Finerty, International & Great Northern, and L. H. Bryan, D. & I. R., whose terms have not yet expired: E. F. Fay, Union Pacific, Cheyenne, Wyo.; F. C. Pickard, master mechanic, C., H. & D., Indianapolis, Ind.; Wm. Hall, C. & N. W., Escanaba, Mich.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

FORTY-THIRD ANNUAL CONVENTION.

ABSTRACT OF COMMITTEE REPORTS AND PROCEEDINGS OF THE CONVENTION.

The convention was opened on Young's Million Dollar Pier, Atlantic City, N. J., on June 20, by the president, Geo. W. Wildin, superintendent motive power N. Y., N. H. & H. R. R.

After the opening prayer, address of welcome from Mayor Stoy and reply by Eugene Chamberlain, the president delivered his address. He extended the thanks of the association to the Hotel Men's Association for their many kindnesses and also to the Supply Manufacturers' Association for the exhibit, etc. In this connection he expressed the appreciation of railroad men in general for the work of the Railway Business Association.

Following this the president advanced a new idea, as follows:

"There comes a time in the history of all organizations when important changes must be inaugurated both in the method of conducting business and in the scope and magnitude of the work to be covered. I feel at this time that as an association we have about reached that point. It is hoped, therefore, that you will pardon my seeming presumption if I enter upon a mild criticism of our usual methods and customs. In doing this, however, I wish it to be most clearly understood that far be it from my intention, and much less my desire, to detract one jolt or tittle from our past achievements. Disloyalty only would brand the man who as presiding officer of this association would wantonly exercise his prerogative for that purpose.

"We have faithfully observed the injunction placed upon us by the framers of our original constitution and by-laws, who in preparing the preamble to it expressed themselves as follows: 'We the undersigned railway master mechanics believe that the interests of the companies by whom we are employed may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business.' Excellent reasons were these for the establishment of this association, and sufficient are they for continuing its existence. But there is urgent need for extending our operations beyond the mere confines of the exchange of ideas and methods.

"As a technical association we stand unique and alone in the field of railway mechanical engineering, no other country to my knowledge having a like organization performing like work. True, we have an esteemed body in this country, known as the American Society of Mechanical Engineers, of which I have the honor to be a member, but the work of that society and its field of research are so far removed from the practical everyday problems in railroading that as a society it is of but little value to the railway mechanical fraternity. It is, therefore, incumbent upon this association to assume a stronger role, and, in addition to holding our annual experience meetings, to get closer together and concentrate our efforts on unifying mechanical opinions on matters of design, construction, specifications, formulæ and policies.

"Possibly we have not had the encouragement we should have received from our superiors, and have not been drawn upon heavily enough to arouse within us the latent powers we possess; consequently without this call upon us we have, as might be expected, assumed a more or less dormant attitude in relation to research work. But it is safe to predict that, with the past two or three years of both national and state legislative activity covering subjects the consideration of which properly belongs to this body, we will in the near future be called upon for action much more strenuous, exacting and positive than we have ever experienced before.

"With this idea in view, and realizing the many vexing problems we as mechanical men will have to solve, I wish to advocate for your most serious consideration the establishment of a permanent centralized technical bureau within our association to be composed of active members of the association having strong technical and practical training, and to have associated with them the officers of the association as members ex-officio. This body should be clothed with authority to act for the association on all important questions arising in the interim between our annual meetings, making a full report to the association in convention assembled at the first opportunity.

"I would further suggest for your consideration that one member of this bureau be a salaried incumbent, the permanency of the office and the emoluments to be such as to permit of its acceptance by an individual fully equipped through experience and training to cope with any and all questions demanding his attention, and who will at all times keep the central body well posted as to the general happenings of interest throughout the country, collect such data as may be required by the body and direct such investigations and research work as may be assigned to him.

"It is also quite necessary that we as an association be more of a unanimous mind on questions that are likely to call for or be made the subject of either federal or state legislation. Such questions should be anticipated and acted upon as far in advance as possible, and then when real legislative action is begun a precedence will have been established, so that the dominating and impelling forces which shape the opinions and recommendations of legislative committees will not emanate from the leader of some political clan or labor organization, but will be found recorded in our proceedings and practices as the crystallized judgment of the members of this great engineering body, whose opinion cannot long be ignored.

"Examples covering the points I have tried to make with reference to getting together are many and varied. Your attention is called to a few which seem to cover the ground fully and will, I hope, substantiate the position I have taken.

"A bill recently introduced in Congress, known as the Federal Boiler Inspection Bill, has created quite a furore and not a little anxiety among railway managers throughout the country. This bill was forced to the front by politicians urged on by labor organization leaders, and it was necessary on the part of this association to take some action in opposition to the forces at work. To this end, although resembling quite closely an eleventh hour repentance, a committee on boiler design, construction and inspection was appointed at the first meeting of our executive committee held at Cleveland last July. This committee has done splendid work in collecting and tabulating data which we hope will enable the American Railway Association committee finally to prosecute successfully its contentions before the House and Senate committees having the bill in charge, but it is well known that the data furnished the committee by the various railways lacked harmony. The opinions and suggestions offered were often diametrically opposite and the whole presented such a lack of uniformity and agreement that it was bewildering, and to glean anything tangible from the mass required almost superhuman effort.

"As members of this association we have had more or less to do with the design and construction of locomotive boilers during the past forty-three years, and as railway mechanical men many years longer, yet we are not agreed on the very simple and fundamental question of the factor of safety for locomotive boilers. As a consequence of this lack of agreement some of us are now facing the peculiar dilemma of strengthen-

ing locomotive boilers now in service both new and old or of prevailing upon the Public Service Commission to reduce the requirements which they arbitrarily established in the absence of an authoritative standard.

"The locomotive headlight question has furnished legislators in many states with a big stick of harassing proportions. On this question, as on many others, we as an association have about as many opinions as we have members, the opinions ranging from the declaration by some that the headlight is an expensive nuisance and should be abolished to the declaration by others that it is a necessary and valuable adjunct and should be of several thousand candle-power.

"It is my opinion that such questions as I have mentioned, as well as purely technical questions, covering design and construction, are well within the work to be covered by this association, and especially the work of the bureau I advocate. Similar problems will arise as long as railways operate, whether the motive power be steam, electricity or something else, and it is our plain duty to provide some medium through which all vital subjects can at all times be fully and thoroughly investigated, and to be in a position at all times to present a united front on all questions involving the common interests of all railways."

REPORT OF SECRETARY.

The report of the secretary showed the membership to be as follows: Active, 952; associate, 20; honorary, 37; total, 1,009. During the year the secretary received $5,466.56 and expended $5,433.40, leaving a balance of $33.16. The treasurers' report showed the balance on hand June 20, 1910, $6,229.94.

ELECTION OF OFFICERS.

The following officers were elected for the ensuing year:

President, C. E. Fuller.

1st Vice-President, H. T. Bentley.

2nd Vice-President, D. F. Crawford.

3rd Vice-President, T. Rumney.

Treasurer, Angus Sinclair.

New Members of the Executive Committee: T. H. Curtis, F. F. Gaines and G. W. Wildin.

SAFETY APPLIANCES.

This subject was referred to the executive committee with the suggestion that they prepare a statement to be sent to each member giving in full the attitude of the Interstate Commerce Commission on the subject of "Safety Appliances for Locomotives.'

TRAIN BRAKE AND SIGNAL EQUIPMENT

This report, in abstract, is printed in connection with the proceedings of the M. C. B. Association, in another part of this issue.

A number of corrections were presented by Mr. Pratt and on motion the report was received and will be submitted to letter ballot.

EDUCATION AS AN ESSENTIAL OF FUEL ECONOMY.

INDIVIDUAL PAPER BY W. C. HAYES*

The best plan to accomplish a saving in the amount of fuel consumed by locomotives on any railroad is a perplexing problem, and one that is forcing itself upon the attention of motive power and managing officers with moving effect, as the operating costs increase and the opportunity for reductions is narrowed to the limit in other channels. Hence, the interest in this question must of necessity increase and every phase of it be closely watched and guarded by those directly in charge and brought up to date, so the subject may be handled in a concrete and systematic way that will correlate all the details to improve the service, with progressive reduction in fuel consumption always in view.

This paper will be confined to and deal largely with that phase of the question having to do with the instruction and educational development of enginemen; in doing so, its scope will be to deal with methods of supervision and instruction of engineers, firemen, hostlers, engine preparers and all others having to do with the preparation of engines for service, so far as maintaining or raising steam on locomotives in service is concerned. The above phases of the subject will be considered under the following heads:

1. Methods of the selection of candidates for the position of firemen.
2. Educational plan recommended before employment.
3. Educational methods to be religiously followed after employment.
4. The methods of education to be followed out on the most approved plan, such as, for instance, a well defined system of instruction, both by class and individual scheme, to be in charge of the road foreman of engines, or a supervisor of locomotive operation.
5. The above to be followed by both written and verbal examinations, to be conducted by the road foreman of engines or by the supervisor of locomotive operation, or a committee that may be selected for that purpose.

Methods of selecting candidates for the position of fireman.

The old hit-and-miss plan, in fact, the one generally followed at this time on most all railroads, consists of hiring a number of men and trying them out by giving them a letter as a learner or student fireman, requiring them to spend a certain specified time learning the duties they will be called upon to perform before being assigned to duty under pay, such as, for instance, riding four or five trips on different classes of engines in the varying grades of service, passenger, switch, freight and helping, receiving instructions from engineers and firemen with whom they may ride.

The latest plan presented, that appeals very strongly to the writer, is one recently introduced by Mr. George H. Baker, president of the American Correspondence School, Brooklyn, N. Y. The plan operates as follows:

A railroad company grants permission to its station agents to act as the representatives of his correspondence course, allowing to each agent a small commission for each student secured. The "Baker plan" then undertakes to educate the candidate in proper methods of firing, incidentally covering all of the principles of combustion, together with instruction in train rules, signals, etc., so as to fit their students for actual service, as well as can be without having practically performed the work. The only responsibility the railroad company assumes is a quasi promise to give preference in employment to all such men as may be available for service when needed, and who can pass all the physical and other employment requirements of the railroad company.

The railroad company with which the author is connected has employed a number of these men on one of its important main line divisions, with very satisfactory results; in fact, in comparison with men who have been employed as firemen on this same division for three, four and five years, their work, in amount of fuel consumed, is more than favorable, and at this time these men are taking a far greater interest in their duties as firemen than are the elder men.

The best educational methods after employment.

Engineers and firemen should be required to fully post themselves in proper methods of combustion, making such a study of the subject as will enable them to apply in everyday practice its cardinal principles. Literature of a well-known character and value can easily be secured that will assist in every way in a study of all branches of the subject. This in all its essentials lays the foundation for progressive examinations of enginemen in fuel economy. The best plan is to furnish to all enginemen a printed list of questions, answers being required in writing, upon which a plan of oral examinations can be based. These examinations to be made either by a committee composed of the master mechanic, road foreman and some general officer who may be delegated for that duty by proper authority, or through any other medium that may suggest itself.

Railroads carrying a sufficient force of road foremen to properly supervise their work, so that they are able to ride with and instruct each individual engineer and fireman, personally, in the proper performance of their duties, in order to see that object-lessons that are given as examples of correct work are being absorbed and instructions are faithfully adhered to, will find that even this sort of supervision can be materially reinforced by holding periodically schools of instruction, in which class lessons can be arranged for the purpose of discussing any one or all of the subjects under which an improvement in fuel and other economies can be made that are directly under the control of the engine crew. This arrangement will have a tendency to spread out the good offices of the road foreman of engines and enable him to cover a much larger field than would be otherwise possible.

The following illustration is presented as an example of what can or may be accomplished by competent supervision and instruction, closely followed to a logical conclusion:

A road foreman of a trunk line having charge of terminal work rode on one of his switch engines for two consecutive hours, and made the following observations: The first hour the pop valve was open continually and the engine was fired and operated by the crew in a slipshod manner. Black smoke was

*Superintendent Locomotive Operation, Erie R. R.

being produced at a great rate, for the reason that large quantities of coal were introduced at one firing and the operation of the engine presented altogether such an unskilful spectacle as to be truly alarming, so far as the visible waste of fuel was concerned. Not a word was said to the crew about their work during the first hour, but at its expiration the road foreman explained to the men in detail the bad features of their work and checked the amount of fuel wasted through these practices, so as to make the matter quite clear to them.

The second hour's operation resulted as follows: The pop valve was kept closed during the entire period; coal was introduced in much smaller quantities and with some degree of skill. Results—no black smoke and much coal saved. The following is the result:

	Lbs.
Coal consumed first hour, 116 shovelfuls at 18 lbs. per shovelful	2088
Coal consumed second hour, 40 shovelfuls at 18 lbs. per shovelful	720
Saving accomplished	1368

(The work done was more severe during the second hour.)

This, of course, is an extreme case, as no such saving can be made upon each engine, but it points the way and certainly shows the kind of supervision necessary in order to obtain best results.

Discussion.—G. H. Baker pointed out how during the past thirty years there had been a wonderful and constant improvement in every feature in connection with railroad operation with the almost single exception of the method of training firemen. These men, in a majority of cases, he said, were now chosen and instructed in practically the same way they were 30 years ago. He drew attention to the tremendous expense that was incurred yearly by the railroads due to this single feature and expressed the belief that it was all entirely useless and would not be permitted much longer. He suggested that it would be advisable for the associations to appoint a committee to investigate and report as follows:—

First, the desirability of preparatory instruction for locomotive firemen, to be mastered before employment. *Second,* the value in fuel economy and superior service, if any, effected by such instruction, as shown by actual comparison of the services of instructed and uninstructed firemen. *Third,* the subjects which proper preparatory instruction should teach. *Fourth,* the character of examination (oral or written) to ascertain if applicants properly understand the instruction, and should they be permitted to enter service without such examination, same to be completed within first month of service. *Fifth,* examine and report upon the merits and defects of any systems of preparatory instruction for firemen now in use.

T. E. Adams spoke at considerable length on this subject, it being one to which he has devoted a great deal of time and study and has been very successful in. His remarks might be summed up as an earnest plea for the determination of a correct principle of instructions. He believed that being determined the rest could easily be taken care of.

E. A. Miller pointed out that the changed conditions now made it much more difficult to obtain satisfactory firemen in any case. While the raw material might be as good as formerly, although in most cases this is not so, the work that they now have to do makes it very difficult to get good results. He believed that with the larger locomotives it is best to lighten the fireman's work as much as possible and that possibly the automatic stoker would eventually solve many of the difficulties of this kind.

Mr. MacBain again drew attention to the plan he had suggested at a previous convention, that he still believed would give the best results in this connection. That plan is to put on men to instruct the firemen, not one traveling fireman on a division to whom is also assigned a dozen other duties, but a man to every 60 or 70 firemen, who should have nothing else to do but instruct them in their work. In this connection he believed that the locomotives should be maintained in the best conditions as encouragement to the firemen to try for the greatest economy. He mentioned the brick arch as a fuel saver and believed that it should be applied to all locomotives possible.

C. W. Cross pointed out that the principles of apprenticeship can as readily be applied to firemen as machinists and stated that in 1903 the New York Central Lines established a set of three year progressive examinations that are best described by the preface of the examination book, which he read as follows:—

"It is the policy of railways to employ men as locomotive firemen who will be capable in time of becoming locomotive engineers. This requires that a man should have at least a common school education, good habits, and be in good physical condition. He should also be quick and alert and a man of sound judgment. Having these qualifications, advancement will come to those who are conscientious in the discharge of their duties and who devote some of their leisure hours to study. As an aid to this end and in order that there may be derived the highest efficiency from a man engaged as a locomotive fireman, there is placed in the hands of every man who is employed as a fireman a code of questions, and it is expected that in the preparation necessary for correct answering of the questions a course of study will be necessary which shall fit him for the work which he is expected to perform. His answers to the questions will indicate how well he has progressed.

"When a man is employed first as a fireman, he will be given the questions on which he will be examined at the end of the first year. Having answered these questions satisfactorily he will then be given the questions for the following year. Having passed this one, he will be given a third and final set of questions on which he will be examined before being promoted to engineman. It is not expected that a man will answer these questions without assistance, and in order that he may understand them properly there has been established a school of instruction in the use of the air-brake, to which all employees are invited; he is also invited to ask the master mechanic, general foreman, road foreman of engines (or traveling engineer), also air-brake supervisors (or instructors), or any other official, for such information as may be required on any of the questions or on any points in connection with the work. He is not only invited, but is urged to do this as the more knowledge the firemen possess the better the results which can be obtained. He will have ample time to study each set of questions, therefore there is no doubt but that with a reasonable amount of study each week the information required to answer satisfactorily the entire list of each series of questions can be easily mastered in the time given.

"In connection with this examination the work done by the fireman during the time of his service and how the work compares with that of other firemen engaged in the same class of service will be noted carefully; also his record as to the use of coal, oil, etc., will be taken into consideration. It is hoped that he will give everything in detail the consideration it merits and realize fully that it is by looking after the little things that a man succeeds. It should be borne in mind that it is only by filling well the position that one has that a person is entitled to the confidence that makes better positions possible."

The following describes the method and time of holding these progressive examinations: "When a man is employed as a fireman, he shall be given the first series of questions and be notified that at the end of the first year of the service he will be required to pass a written and oral examination thereon, under the direction of the division mechanical officer and air-brake supervisor or air-brake instructor. After passing the first series of questions he will be given the second series of questions and be notified that at the end of another year of service he will be required to pass a written and oral examination thereon, under the direction of the division mechanical officer and air-brake supervisor (or air-brake inspector). If a man fails to pass the first and second examinations, he shall be dropped from the service. If a man has passed 80 per cent or more in all examinations, he shall be given a diploma. When he has passed the second series of questions he will be given the third series of questions and be notified that before being promoted and within not less than one year he will be required to pass a written and oral examination before a general board of examiners. At the third examination, if a man shall fail to pass 80 per cent of the questions asked, two more trials, not less than two months apart, will be given him to pass the same examination. If he then fails to pass by a percentage of 80 per cent, he shall be dropped from the service. Firemen passing the third and final series of questions will be promoted in order of their seniority as firemen, except that those who pass on the first trial shall rank, when promoted, above those who pass on the second or third trial, and those passing on the second trial shall rank above those who pass on the third trial. Enginemen employed shall be required to pass the third series of questions before entering the service."

SELF DUMPING ASH PANS

H. T. Bentley (C. & N. W.) opened the topical discussion on this subject as follows: Are self dumping ash pans entirely satisfactory, and if not what should be done to make them so?

In accordance with Federal requirements we equipped our engines with self dumping or legal ash pans, and had all in operation by January 1 of this year. Before going into the application of them we made a careful study of the situation, and went over the drawings of practically every self dumping pan that was then in use, and decided, as we had a number of new engines from the locomotive builders equipped with the bottom slide apparatus, that it would be the most satisfactory arrangement for such engines. Therefore, after considerable thought, we worked up a design that would answer for the largest number of engines, and made standard for those engines the slide, hopper casting, operating rods, cranks, etc.

We had to settle a number of things that came up, such as an arrangement that could be worked from either side, a device that could not be opened from the deck so as to overcome the possibility of dumping live cinders on bridges, etc., where they might cause trouble; make provision for thawing them out in winter, and provide sufficient openings for air to enter without letting fire out. We designed every part amply strong and felt that we were going to be rewarded by having a device that would be reasonably free from causing us trouble, but have been disappointed, and in making inquiries from our neighbors find they have all had more or less difficulty with pans warping and getting out of shape, so that live cinders were dropped, setting fires, and causing other trouble. During cold weather the slides would freeze solid, notwithstanding the fact that we had a heater attached to each one to overcome this difficulty.

It has been suggested that we make the hopper entirely of cast iron, but in looking over pans on other roads we find they have tried this and had to abandon its use, substituting cast steel, which apparently is very little better. On a road having all steel bridges, and running through a well settled territory, the dropping of a few live cinders is not a serious matter, but out in the country, with wooden bridges, dry grass, etc., it is a different proposition. It has been proposed that we have a water connection from the boiler to the ash pan so that occasionally the live cinders can be wetted down. This may be satisfactory in summer, but in winter it might cause trouble. Some people have turned the injector overflow in the pan, which might be satisfactory in the south, but in the north the pan might freeze up.

A number of roads use a steam jet for blowing cinders out of flat bottom pan, and we understand it works satisfactorily with certain kinds of fuel, but with Iowa or Illinois coal we are afraid the clinkers could not be blown out with steam. The object of this paper is to bring about a discussion as to the difficulties or troubles experienced as a result of the ash pan bill that was passed, and what can be done to overcome them.

Discussion.—J. F. DeVoy stated that he believed the association should enter a very strenuous protest against the passage of bills compelling railways to apply devices which in many cases are an absolute detriment to locomotives.

FREIGHT TRAIN RESISTANCE; ITS RELATION TO AVERAGE CAR WEIGHT.

By Edward C. Schmidt.

Train resistance varies not only with the train speed, but also with the average weight of the cars of which the train is composed. At a given speed the tractive effort required for each ton of weight of the train will be greater, for example, for the train which is composed of cars of 20 tons average gross weight than for the train composed of cars which weigh, on the average, 50 tons each.

While this fact has been known for some years, it has found inadequate expression and but little application. In the establishment of their tonnage ratings many railroads have altogether ignored it. In the tonnage ratings of a few roads this variation of resistance with car weight is recognized to the extent of allowing a difference in rating between trains composed of loaded cars and those consisting entirely or partially of empty cars. Generally in such systems a certain amount is allowed arbitrarily to be added to the weight of empty cars in determining, for purpose of rating, the weight of the train in which they are found. In such ratings no distinction is made between loaded cars of various weights, although such weights vary from 25 to 70 tons. A still smaller group of railroads have fully recognized the significance of the facts above stated in establishing their tonnage ratings, which in such cases are usually termed "adjusted" or "equated" ratings. Under these adjusted ratings the actual weight of the train allotted to a particular locomotive varies according to the number of cars in the train. The ratings for the same locomotive with trains of 40, 60 and 80 cars, for example, will be different in each of the three cases. This, of course, is, in effect, a variation of the rating with respect to the average car weights. Most of these adjusted ratings have been empirically determined. In the few cases where they rest upon experiments made to determine the variations in train resistance with respect to car weight, the data and results of such experiments have not been fully published. Existing train resistance formulæ likewise fail in most cases to take into account these variations of resistance with car weight, and probably much of the divergence among them is properly to be ascribed to this fact.

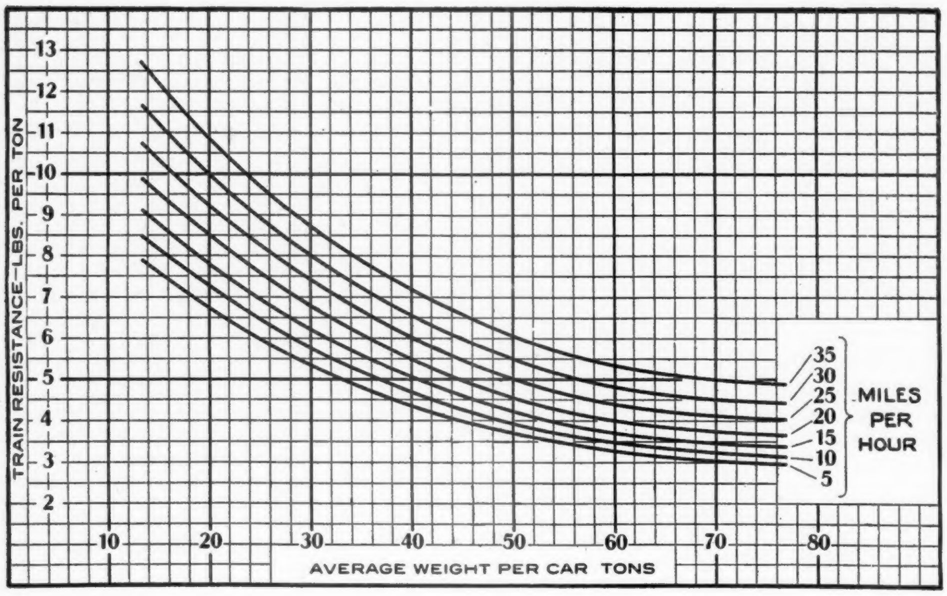


FIG. 1.

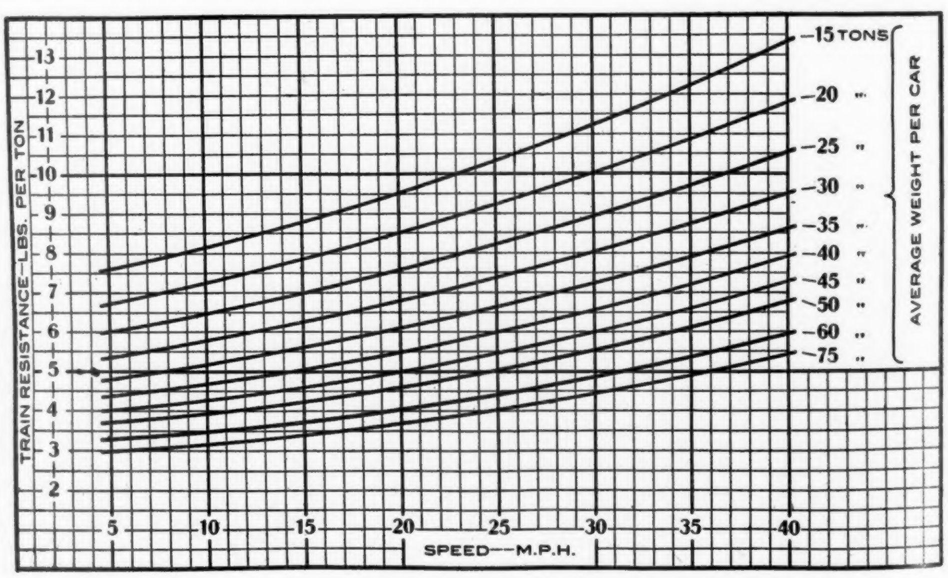


FIG. 2.

Purpose of the Tests.—In view of the facts just stated it has seemed desirable to make the tests whose results are here recorded. They were planned to determine the resistance of freight trains under the usual conditions of operation; and were designed to disclose at the same time, if possible, the relation existing at any given speed between train resistance and average car weight. Since the chief use of such information is in the production of locomotive ratings, the condition of the tests have been made like those which prevail in normal freight train operation. The speed range, for example, is from 5 to 35 miles per hour, and the trains experimented upon were trains in regular service and usual in their make-up. The track upon which the tests were made is believed to be representative of good main-line construction.

The tests have been made as part of the research work of the Engineering Experiment Station of the University of Illinois, conducted by the Railway Engineering Department. They were begun in April, 1908, and were completed in May, 1909. All tests were made by means of Test Car No. 17, a dynamometer car, owned jointly by the University of Illinois and the Illinois Central Railroad, and were carried out on the Chicago Division of this road.

In the preparation of the report the aim has been to present it in as brief a statement of the results and conditions as is compatible with a clear understanding of the tests. The original report of these tests was presented to the American Society of Mechanical Engineers, and has been published in the Society journal for May, 1910. The results of the tests will also be published as a bulletin of the Engineering Experiment Station of the University of Illinois. This bulletin will contain, in addition to the facts here published, more detailed information concerning the track, the dynamometer car and the methods of calculation, as well as the tonnage record for each train and the calculated results and resistance curve for each test.

Throughout the report the terms "resistance" and "train resistance" mean the number of pounds of tractive effort required for each ton of the train in order to keep it in motion on straight and level track, at uniform speed and in still air. The report deals exclusively with the resistance of the train behind the locomotive tender. Locomotive and tender resistance are not discussed.

SUMMARY AND CONCLUSIONS.

Summary.—The report deals with the results obtained from tests of thirty-two ordinary freight trains, whose chief characteristics were as follows:

	Minimum.	Maximum.
Total weight, tons.........	747	2,908
Average weight per car, ton	16.12	69.92
Number of cars in the train	26	89

The trains whose average weights were less than 20 tons or more than 60 tons were composed of cars of nearly uniform weight; while those whose average car weights were between 20 and 60 tons were either homogeneous or mixed as regards the weight of the individual cars.

The tests were made during generally fair weather. The minimum air temperature during any test was 34 degrees; the maximum, 82 degrees. The approximate average wind velocity prevailing throughout one test was 25 miles per hour; during all the others it was less than 20 miles per hour.

The tests were made upon well-constructed and well-maintained main-line track, 94 per cent. of which is laid with 85-pound rail, the remainder being laid with 75-pound rail. Except through station grounds, where screenings or cinders are used for ballast, the track is full ballasted with broken stone.

Conclusions.—The results of the tests are presented in Figs. 1 and 2, in Table 3, and in the equations (Fig. 3). The curves, the table and the equations are each different expressions of the same facts. It is believed that by their use one may safely predict the probable total resistance of *entire* freight trains at various speeds, when running upon straight and level track of good construction during weather when the temperature is above 30° F. and the wind velocity is not more than 20 miles per hour, provided the *average* weight of the cars composing the train be known.

TABLE 3

VALUES OF RESISTANCE AT VARIOUS SPEEDS AND FOR TRAINS OF DIFFERENT AVERAGE WEIGHTS PER CAR

THE VALUES ARE DERIVED DIRECTLY FROM THE CURVES OF FIGURE 11 AND REPRESENT THE FINAL RESULTS OF THE TESTS

SPEED MILES PER HOUR	TRAIN RESISTANCE — POUNDS PER TON. COLUMN HEADINGS INDICATE THE AVERAGE WEIGHTS PER CAR													SPEED MILES PER HOUR
	15 TONS	20 TONS	25 TONS	30 TONS	35 TONS	40 TONS	45 TONS	50 TONS	55 TONS	60 TONS	65 TONS	70 TONS	75 TONS	
5	7.6	6.8	6.0	5.4	4.8	4.4	4.0	3.7	3.5	3.3	3.2	3.1	3.0	5
6	7.7	6.9	6.1	5.5	4.9	4.4	4.1	3.8	3.5	3.3	3.2	3.1	3.0	6
7	7.8	7.0	6.2	5.5	5.0	4.5	4.1	3.8	3.6	3.4	3.2	3.1	3.1	7
8	8.0	7.1	6.3	5.6	5.0	4.6	4.2	3.9	3.6	3.4	3.3	3.2	3.1	8
9	8.1	7.2	6.4	5.7	5.1	4.6	4.2	3.9	3.6	3.4	3.3	3.2	3.1	9
10	8.2	7.3	6.5	5.8	5.2	4.7	4.3	4.0	3.7	3.5	3.3	3.2	3.2	10
11	8.3	7.4	6.6	5.9	5.3	4.8	4.3	4.0	3.7	3.5	3.4	3.3	3.2	11
12	8.4	7.5	6.7	6.0	5.4	4.8	4.4	4.0	3.8	3.6	3.4	3.3	3.3	12
13	8.6	7.6	6.8	6.1	5.5	4.9	4.5	4.1	3.8	3.6	3.5	3.4	3.3	13
14	8.7	7.8	6.9	6.2	5.5	5.0	4.5	4.2	3.9	3.7	3.5	3.4	3.4	14
15	8.8	7.9	7.0	6.3	5.6	5.1	4.6	4.2	3.9	3.7	3.6	3.5	3.4	15
16	9.0	8.0	7.1	6.4	5.7	5.1	4.7	4.3	4.0	3.8	3.6	3.5	3.5	16
17	9.1	8.1	7.2	6.5	5.8	5.2	4.8	4.4	4.1	3.9	3.7	3.6	3.5	17
18	9.3	8.3	7.4	6.6	5.9	5.3	4.8	4.5	4.1	3.9	3.7	3.7	3.6	18
19	9.4	8.4	7.5	6.7	6.0	5.4	4.9	4.5	4.2	4.0	3.8	3.7	3.6	19
20	9.6	8.5	7.6	6.8	6.1	5.5	5.0	4.6	4.3	4.0	3.9	3.8	3.7	20
21	9.7	8.7	7.7	6.9	6.2	5.6	5.1	4.7	4.3	4.1	3.9	3.9	3.8	21
22	9.9	8.8	7.9	7.0	6.3	5.7	5.2	4.8	4.4	4.2	4.0	3.9	3.8	22
23	10.0	9.0	8.0	7.1	6.4	5.8	5.3	4.9	4.5	4.3	4.1	4.0	3.9	23
24	10.2	9.1	8.1	7.3	6.6	5.9	5.4	4.9	4.6	4.3	4.2	4.1	4.0	24
25	10.4	9.3	8.3	7.4	6.7	6.0	5.5	5.0	4.7	4.4	4.2	4.1	4.0	25
26	10.5	9.4	8.4	7.5	6.8	6.1	5.6	5.1	4.8	4.5	4.3	4.2	4.1	26
27	10.7	9.6	8.5	7.7	6.9	6.2	5.7	5.2	4.8	4.6	4.4	4.3	4.2	27
28	10.9	9.7	8.7	7.8	7.0	6.3	5.8	5.3	4.9	4.7	4.5	4.4	4.3	28
29	11.1	9.9	8.8	7.9	7.1	6.5	5.9	5.4	5.0	4.8	4.6	4.5	4.4	29
30	11.3	10.0	9.0	8.0	7.3	6.6	6.0	5.5	5.1	4.9	4.7	4.5	4.5	30
31	11.4	10.2	9.1	8.2	7.4	6.7	6.1	5.6	5.2	5.0	4.8	4.6	4.5	31
32	11.6	10.4	9.3	8.3	7.5	6.8	6.2	5.8	5.3	5.0	4.9	4.7	4.6	32
33	11.8	10.5	9.4	8.5	7.6	7.0	6.3	5.9	5.4	5.2	5.0	4.8	4.7	33
34	12.0	10.7	9.6	8.6	7.8	7.1	6.5	6.0	5.5	5.3	5.1	4.9	4.8	34
35	12.3	10.9	9.7	8.8	7.9	7.2	6.6	6.1	5.7	5.4	5.2	5.0	4.9	35
36	12.5	11.1	9.9	8.9	8.0	7.4	6.7	6.2	5.8	5.5	5.3	5.1	5.0	36
37	12.7	11.2	10.0	9.0	8.2	7.5	6.9	6.4	5.9	5.6	5.4	5.2	5.1	37
38	12.9	11.4	10.2	9.2	8.3	7.6	7.0	6.5	6.0	5.7	5.5	5.3	5.2	38
39	13.1	11.6	10.4	9.4	8.5	7.8	7.1	6.6	6.2	5.8	5.6	5.4	5.3	39
40	13.4	11.8	10.6	9.5	8.6	7.9	7.3	6.8	6.3	6.0	5.7	5.6	5.5	40

The results are applicable to trains of all varieties of make-up to be met with in service. They may be applied, without incurring material error, to trains which are homogeneous and to those which are mixed as regards individual car weight.

The results are primarily applicable to trains which have been for some time in motion. When trains are first started from yards, or after stops on the road of more than about twenty minutes' duration, their resistance is likely to be appreciably greater than is indicated by the results here presented. In rating locomotives no consideration need be given this matter, except in determining "dead" ratings for low speeds, and then only when the ruling grade is located within six or seven miles of the starting point or of a regular road stop.

It is to be expected that some trains to be met with in service will have a resistance about 9 per cent. in excess of that indicated by Figs. 1 and 2, due to variations in make-up or in external conditions within the limits to which the tests apply. If operating conditions make it essential to reduce to a minimum the risk of failure to haul the allotted tonnage, then this 9 per cent. allowance should be made. This consideration, like the one preceding, is important only in rating locomotives for speeds under 15 miles per hour. At higher speeds, the

occasional excess in the resistance of individual trains will result in nothing more serious than a slight increase in running time. It should be emphasized that this allowance, if

Train Resistance Formulæ—

When $W = 15$ tons; $R = 7.15 + 0.085\,S + 0.00175\,S^2$.
" $W = 20$ " ; $R = 6.30 + 0.087\,S + 0.00126\,S^2$.
" $W = 25$ " ; $R = 5.60 + 0.077\,S + 0.00116\,S^2$.
" $W = 30$ " ; $R = 5.02 + 0.066\,S + 0.00116\,S^2$.
" $W = 35$ " ; $R = 4.49 + 0.060\,S + 0.00108\,S^2$.
" $W = 40$ " ; $R = 4.15 + 0.041\,S + 0.00134\,S^2$.
" $W = 45$ " ; $R = 3.82 + 0.031\,S + 0.00140\,S^2$.
" $W = 50$ " ; $R = 3.56 + 0.024\,S + 0.00140\,S^2$.
" $W = 55$ " ; $R = 3.38 + 0.016\,S + 0.00142\,S^2$.
" $W = 60$ " ; $R = 3.19 + 0.016\,S + 0.00132\,S^2$.
" $W = 65$ " ; $R = 3.06 + 0.014\,S + 0.00130\,S^2$.
" $W = 70$ " ; $R = 2.92 + 0.021\,S + 0.00111\,S^2$.
" $W = 75$ " ; $R = 2.87 + 0.019\,S + 0.00113\,S^2$.

FIG. 3.

made, is to be added to the resistance on level track—not to the gross resistance on grades.

Discussion.—Mr. Bentley (C. & N. W.) asked the author concerning his experience with the resistance of different size journals carrying the same total load, that is, it is the general opinion of trainmen that a car having 4¼ by 8 in. journals and containing a certain load gives less resistance than a car with 5½ by 10 in. journals having the same total load. Prof. Schmidt replied by stating that there were no particular experiments made on this point but that theoretically it would be a fact that the smaller journals would offer less resistance.

Mr. Seley drew attention to the fact that this was the first paper relating to tonnage rating that had been presented for a number of years and stated that the earlier papers had been found to be of great practical value and this one would undoubtedly prove to be no exception. He regarded it as a very valuable contribution to the association and moved a vote of thanks to Prof. Schmidt. This motion was carried.

MECHANICAL STOKERS.

Committee:—T. Rumney, Chairman; E. D. Nelson, C. E. Gossett, J. A. Carney, Geo. Hodgins.

The report of the committee contained descriptions of the Crawford stoker and the Street stoker, both of which have been developed since last year. Both will be the subject of separate articles in a later issue of this journal.

It also contained some references to the service of the stokers that were described in last year's report, showing that in general they are operating satisfactorily. The report concluded as follows:

Our experience has developed that the stoker is not mechanically perfect. Therefore, it requires considerable skill and care on the part of the enginemen to avoid failures. The stoker companies have made several improvements in the design of the machines in the past year, and, in view of the improvements that have been made that have so materially improved its performance, it is reasonable to assume that this machine will yet prove a successful device for automatic firing of locomotives.

It could hardly be expected that mechanical stokers at the present stage of development could show an economy over hand firing by an expert fireman, but it is considered that, if economy is expected, it must be looked for in the comparison with the average of all grades of firemen in regular service. Designers of the present day are more interested in effecting practicability and security against failure rather than the promoting of efficiency by its use, as this effect is more or less taken for granted with any properly designed and thoroughly practical stoker.

The main defect of the present stokers seems to be, to a very great extent, with the coal-conveying apparatus, and it is the failure of this particular feature which usually makes the stokers of to-day somewhat unreliable.

The committee considers the progress and the development of the mechanical stokers during the past years as indicative of a determined effort to build stokers which will be in every way a success, and is convinced that the mechanical stoker is destined to be a very important factor in the operation of heavy locomotives in the not very distant future.

Discussion—Mr. Street stated that his stoker was in service on the Lake Shore & Michigan Southern Railway, between Ashtabula and Youngstown, Ohio, and invited any one interested to take a ride on the locomotive and watch its operation. This invitation was seconded by Mr. MacBain.

T. O. Sechrist stated that there was a Hanna stoker working on a Mallet compound locomotive on the C. N. O. & T. P. Railway between Oakdale and Danville, Ky. This stoker had given most satisfactory results in that service and had shown itself capable of handling trains that were impossible with hand firing. They were now installing twelve more Hanna stokers on the same division and it is the intention to equip all of the largest engines with it. The stoker was able to satisfactorily use coal which cost ninety cents a ton as compared with $1.35 coal used when firing by hand.

J. F. DeVoy reported that the Strauss stoker, which had been in operation on the Milwaukee for over a year, had been giving very satisfactory results and quoted from official reports many trips which showed the stoker to be successful in every way.

J. F. Walsh stated that five Strauss stokers used on the C. & O. were giving as good results as hand firing on their very large engines. The locomotives equipped with stokers are working on the river grade, handling trains of 4,500 tons. He expressed the opinion that the stoker to be thoroughly satisfactory must be made more attractive to the firemen. Means should be provided for conveying the coal from the tender to the hopper.

Mr. Franey stated that he had personally fired the engine equipped with the Street stoker for fifty miles, the train weighing 3,400 tons, and that during this trip he did not find it necessary to remove a heavy overcoat. It was not necessary to open the fire door during the whole trip. He also reported a number of other trips which he had personally made on the locomotive that showed excellent results. He stated that observations indicate a considerable saving of coal by the use of a stoker, and that tests were now being made to verify this. In regard to smoke the density depended upon the amount of coal being fired. With heavy firing black smoke was emitted constantly. With lighter firing the smoke was a lighter color, but was still constant. He stated that the maintenance of the stoker had proved to be very light.

Mr. Bentley did not agree with the gentleman who stated that the stoker could be used satisfactorily by inexperienced men. He believed that no matter which stocker was used it would be necessary for the fireman to have considerable experience in order to get the best results from it. He also brought up the question of smoke as being very important and stated that in the large cities this was one of the most serious problems that the stoker is expected to remedy.

Mr. Hayes stated that on the Erie experience with stokers so far had not been such as to justify any general expression in their favor. There has been five or six stokers in service on that road and it was found that they took about one-third more coal than hand firing. He believed that the education of the firemen would accomplish better results than the stoker unless the latter was greatly improved over those that he knew.

George L. Fowler reported a recent trip with the Crawford stoker and stated that its operation was entirely smokeless. While no tests had been made as yet, observations indicated that this stoker gave some fuel economy. It was entirely successful so far as keeping up the steam was concerned.

LOCOMOTIVE FRAME CONSTRUCTION.

By H. T. Bentley.

The subject of the paper I was asked to write was subdivided under two heads, as follows:

First: The investigation of design of driving boxes, brasses, shoes, wedges, binders and frames, that will give increased mileage to locomotives between shoppings.

Second: Frame construction for engines with outside valve gear.

With our heavy locomotives, it is getting to be quite a problem to keep them running without having frequently to drop wheels and refit driving-box brasses, take up lateral wear, line down wedges, etc., and the object of this paper is to bring out a discussion as to what has been, or can be, done to keep engines off the drop pit, and increase their life between general repairs. We are nearly all agreed, I think, that if it were pos-

sible to keep our driving-box brasses, shoes and wedges snug, and free from pounding, there would be less trouble with frame breakage, and our rod brasses would not need renewing so often.

With the above ideas in mind, I am giving a few suggestions that may possibly enable us to keep an engine out of the shop until such time as the driving axles need renewing, unless a frame breakage occurs to take engine out of service.

To get the best results, driving boxes should be made of cast steel, and designed of such proportions in shoe and wedge fit as to give long life, and with an adjustable or removable hub liner, so that lateral motion could be taken up with wheels in place.

The driving-box brasses should be of ample size and made of suitable material for obtaining long life, and of a removable type so that it would be possible to quickly replace them without having to drop wheels.

Shoes and wedges should be of such a size so that a large bearing surface would be in contact with driving boxes. With the ordinary design, the shoe and wedge face is altogether too small, and very rapid wear takes place. Flangeless shoes and wedges should be used to overcome the trouble experienced with flanges breaking. To facilitate the lining down of wedges, arrangements should be made so that they could be removed without disturbing the binders, or underhung springs, if used; the wedge bolts should be of sufficient strength and so arranged that in case of breakage it would be an easy matter to replace them.

Binders to be so designed that they will securely hold the frame jaws together, and prevent movement, but yet of such construction that they can readily have wear taken up when necessary.

Frames.—Most roads have more or less trouble with frame breakages, and, if these could be eliminated by either improving the design or making them of some material that would stand up under the shocks they are subjected to, a step in the right direction would be made.

In looking over a mechanical paper some time ago, I noticed an article bearing on the great amount of frame breakage that was occurring with engines having the Walschaert valve gear. Upon looking into this, on our own road, I found we are not having the slightest trouble; not a single case of frame breakage has occurred on any outside gear engine during the past four years.

Frame Construction for Engines with Outside Valve Gear.—As most locomotives are now being built with outside valve gear, there is very little difficulty in designing a suitable cross bracing that will add materially to strength and life of frames.

In sending out a Circular of Inquiry on the subject under discussion, a number of questions were asked, and the replies are summed up after each question, following:

Have you any suggestion to make in the way of improving the driving box now in general use, and, if so, what do you recommend?

Of twenty-six answers, sixteen replied, "No," whereas the balance suggested using heavy steel boxes, except in one case, where it was recommended that the pedestal jaws be spread farther apart, so that heavier *cast-iron* boxes could be used.

Have you any way of taking up lateral wear in driving boxes without removing them, and, if so, how is it done?

Very little has been attempted in this direction, although replies indicate there is a great need of something that will enable this to be done.

Are you using driving boxes with brasses that can be taken out without dropping wheels, and, if so, what kind, and are they entirely satisfactory?

Notwithstanding the desirability of such an arrangement, only five roads report using anything of the kind, and all are using the same patented device, experimentally; in three cases satisfactorily, in one case it has not been in service long enough to report on, while the fifth user did not find it entirely satisfactory, but did not state in what respect it failed.

What mixture or special metal do you use in driving-box brasses, and is it entirely satisfactory? Do you use grease for lubricating switch engines, and is it giving satisfaction? If not, what do you suggest?

In the first section of this question, most roads reply that they are making their own mixture, of copper 80 per cent., tin 10 per cent. and lead 10 per cent., with very satisfactory results, while a few are purchasing special brands, which give good service.

In answer to second part of question No. 4, there appears to have been a difficulty experienced while using grease in switch engines, and it early became evident that the kind of grease and perforated plates working satisfactorily on road engines would not answer the purpose for the slower moving switch engine, and, therefore, a thinner grease and perforated plates with larger holes were introduced, and this combination appears to give better results.

Do you use adjustable or solid shoes and wedges, and are they satisfactory?

The general practice appears to favor the solid shoe with adjustable wedge, and, as a whole, is satisfactory, although with limited bearing surface considerable wear takes place. With engines having Walschaert or other outside gear, there is no reason why the frame jaws cannot be designed to get a width of eight to ten inches, if desired, so that the pressure per square inch could be greatly reduced. On a large number of European engines a solid pedestal of great width is used, with very satisfactory results.

Do you have much shoe and wedge flange breakage? If so, how do you overcome it?

Considerable trouble appears to have been experienced in this direction, and has been overcome in some cases by using bronze shoes and wedges; in others, by thickening flanges where possible, and, on most roads, frame jaws are now rounded off so that a good fillet can be left in shoes and wedges. We have entirely overcome the breakage of flanges by simply leaving them off, and using side plates riveted on frame, the flanges of driving box coming in contact with these side plates, instead of the flanges of shoes and wedges as formerly.

What width of bearing face do you have on shoes and wedges where they come in contact with driving boxes?

The replies indicate that this varies on different engines and roads, the minimum being 4 inches with 7¾ inches as a maximum, depending on the size of engine. With Consolidation engines in service on the Chicago & North Western Railway we have a wedge face of 8¼ by 17½ inches, with a pressure per square inch of 122.8 pounds, as compared with our former standard freight engine with 6¼ by 17 inch wedge face, with a pressure of 184.72 pounds per square inch.

With outside valve-gear engines, have you tried to increase the width of shoe and wedge face, and, if so, how?

In no case does there appear to have been an attempt made, according to replies received, to increase frame jaws on engines having outside valve gear, and yet it is a simple proposition, and by doing so very much increased wearing surface could be obtained.

Have you any way of taking down wedges, without removing binders or driving box, and, if so, please furnish blue-prints?

In no case reported has this been attempted, although it can be accomplished by using flangeless wedges and cutting away the inside flange of driving box, on wedge side, and what was formerly a four or five hour job, depending upon size of engine, can be accomplished in less than an hour.

Do you use brass or cast-iron faced shoes and wedges, and which do you recommend?

The general practice appears to favor cast iron for this purpose, but a number of roads prefer bronze shoes and wedges where steel boxes are used, while a few people seem to like a bronze liner on steel box, and then use a cast-iron shoe and wedge. With this latter arrangement, we have not had very good results on account of difficulty keeping liners fast on box, and our present practice is to use cast-iron shoes and wedges against steel boxes in freight service, and bronze bearing on passenger engines.

Can you line down shoes and wedges without taking them out to apply liners, and, if so, how?

The replies are practically the same as to question 9, except that occasionally loose liners are inserted behind wedge, which, however, can only be done by taking binder down, so that what should be a simple job is a difficult and expensive one.

With underhung springs can you remove and replace broken wedge bolts without taking binders down, and, if so, please show how?

Where underhung springs are used, it seems impossible on most roads to remove or apply wedge bolts without removing springs. We had a similar difficulty, and practically overcame it by making binders with slotted holes, which enabled us to take out and replace wedge bolts with springs in place, thus reducing the job from a big to a small one.

Which type of binder do you find the most satisfactory, and why?

The pedestal cap type meets with most favor, as replies from fourteen roads indicate it is their preference, and that frame breakage is reduced where used. The strap binder is next best thought of, seven replies being in favor of it. The clamp over frame jaw lugs is used on four roads on account of simplicity, and only one road is in favor of using the thimble and bolt.

My personal preference is the pedestal cap type.

Have you anything to suggest in the way of a binder that will take up wear without having to be upset and refitted?

The replies of persons using the pedestal cap type indicate that this style of binder does enable the wear to be taken up with less trouble and expense than any other make, in which conclusion I concur.

What suggestion have you to offer in regard to frame construction on engines with outside valve gear?

The proper cross bracing of frames is the most logical use to make of the space that was formerly taken up by valve gear, and will do more to overcome frame breakage than almost anything else, is the general opinion. One suggestion is to use upper and lower rails over cylinder casting. This design can, and is used, however, with engines not having outside valve gear, and is a great help in reducing front frame breakages and loose cylinders.

Do you have as much trouble with frame breakage when using outside valve gear as you did when using Stephenson gear? If so, how do you account for it? If not, how do you account for it?

There seems to be a reduction of frame breakages with engines having outside valve gear, on account of them being provided with suitable cross bracing. In our experience with engines of exactly the same size and make, one having the inside, and the other the outside gear, the former are continually in the shop with broken frames, while the latter, with Walschaert gear, have never given us a minute's trouble in this direction; but frames are braced laterally, which we consider the cause of our freedom from breakage.

Do you use cross bracing between frames of outside gear engines? If so, does it stiffen up and reduce frame breakage?

Where outside gears are in use, the frames are generally braced laterally and with splendid results, judging from replies received. Some roads have had such short experience with outside geared engines that they are not in a position to report intelligently.

Have you any suggestions to make that will decrease the breakage of locomotive frames?

The suggestions offered are various, and may be summarized as follows: Heavier frames. Keep pounds out of driving boxes. All weight-carrying points on frames to be braced to boiler. Make frames of best material. Increase depth of frame in proportion to the tractive power. Make frames in one piece with large radii where possible. Good material properly used.

Do you use steel or iron frames? Which is most satisfactory?

Cast-steel frames, when properly designed and annealed, appear to be just as satisfactory as wrought iron. Great strides have been made in foundry practice during the past few years, so that first-class castings can be obtained.

In conclusion, I believe there is a great field ahead for the further study of this subject, so that repairs to driving boxes, shoes, etc., will be simplified, and work now taking several hours can be done in very much less time.

Discussion—Mr. MacBain recounted how six years ago the New York Central experimented by lengthening the driving box brasses on Atlantic type locomotives about 20 per cent. or from 12 to 14⅛ inches. The extension was permitted by shifting the eccentrics and putting them on an off-set eccentric rod. Previous to that time it was found that the left main brass would run from 35,000 to 40,000 miles. The first one of the wider bearing ran 122,500 miles and the wear was not greater on the left main brass than on the others. The same form was immediately applied to other engines and it has been used with uniformly good results since that time.

Mr. Gaines objected to the use of cast steel driving boxes. He stated that he was trying at present to substitute cast iron boxes for all the cast steel designs on his road. In connection with frames he stated that it was advisable to connect points on the frames wherever the weight is transferred, directly to the boiler; in this manner many frame breakages are avoided.

Mr. DeVoy stated that he believed the increased frame bracing was the reason for decreased frame breakage on engines having outside valve gear. He also believed that you could reduce the weight of the frames by fully 25 per cent. by the use of properly designed braces and that the combined weight of frame and braces would be 15 to 20 per cent. less than the frame which was not properly braced.

Mr. Bentley recounted his experience with removable driving box brasses which covered a service of a number of years. He stated that the savings which were obtained by removable brasses were truly remarkable. In connection with these braces they were using flangeless shoes and wedges with great success.

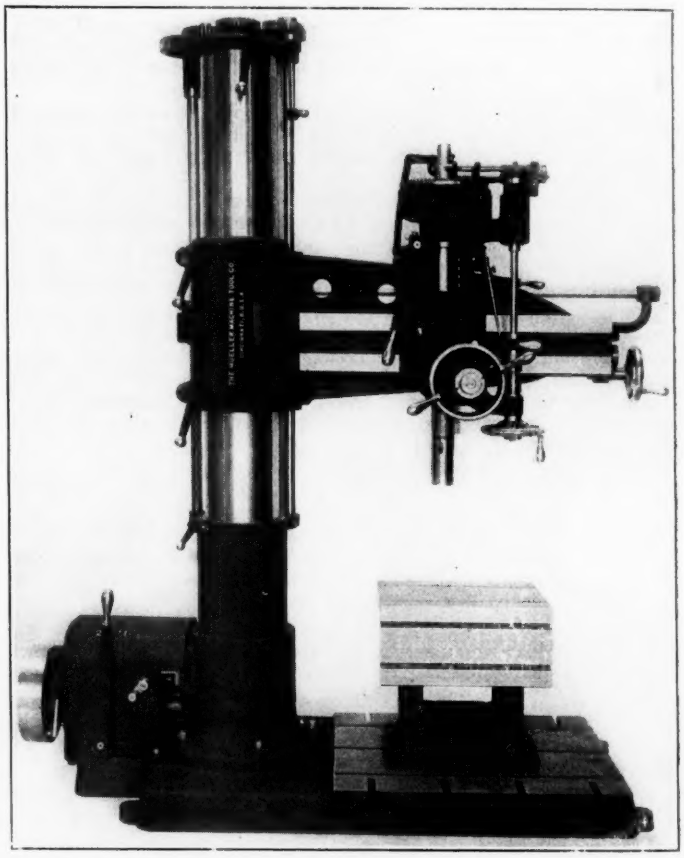
(Reports of committees and discussion on the following subjects will appear in the next issue: Superheaters; Capacity of Safety Valves; Design, Construction and Inspection of Locomotive Boilers; Locomotive and Shop Operating Costs, and Steel Tires.)

NEW DESIGN OF RADIAL DRILL.

A recent design of radial drill, adapted to accurate and fast work required in a modern railroad shop, is shown in the accompanying illustration. This drill is built in the 2½, 3 and 3½ foot sizes, making it suitable for all ordinary work.

It will be seen that the arm is very well proportioned and has a very wide bearing on the column, that is ground to size, making a very rigid arrangement. It can be lowered at twice the elevating speed, being controlled by a lever located on the cap of the column within easy reach. It can be swung in a full circle around the column.

The head is traversed by means of a double pitch screw, provided with a graduated dial on the end of the arm, which enables the operator to bring it to within .001 inches of the desired position. By means of a lever located on the head directly in front



A GOOD DESIGN OF PLAIN RADIAL DRILL ADAPTED TO R. R. SHOP WORK.

of the operator, the back gears can be engaged or disengaged without the slightest shock while the machine is in motion.

High carbon crucible steel is used in the construction of the spindle, which is provided with an automatic trip with a safety stop. Another desirable feature is the range of twelve changes of speed which are instantly available without stopping the machine. In connection with this, there is a bronze speed plate on the arm which enables the operator to select the proper speed at a glance.

There are eight changes of feed in geometrical progression to each spindle speed, and the feed can be used either as a positive or as a friction feed.

Very heavy tapping operations are possible and it is claimed that it is impossible to break a tap on this machine because it is provided with an adjustable gauge nut which causes the spindle to slip when the tap reaches the bottom of a hole. The tapping mechanism permits taps to be backed out at accelerated speed.

Six changes of speed are provided by a speed box of the geared friction type which is simple in construction and easily operated.

The base of this drill is unusually heavy where the column is bolted on and the entire machine is very compact. It is made exceptionally rigid, eliminating all vibration, by casting the column in one piece with four internal ribs extending its entire length. The drill is manufactured by the Mueller Machine Tool Co., of Cincinnati, Ohio, and may be equipped for any style of motor drive. It can also be furnished with a universal box, plain swinging, worm swiveling, or round table.

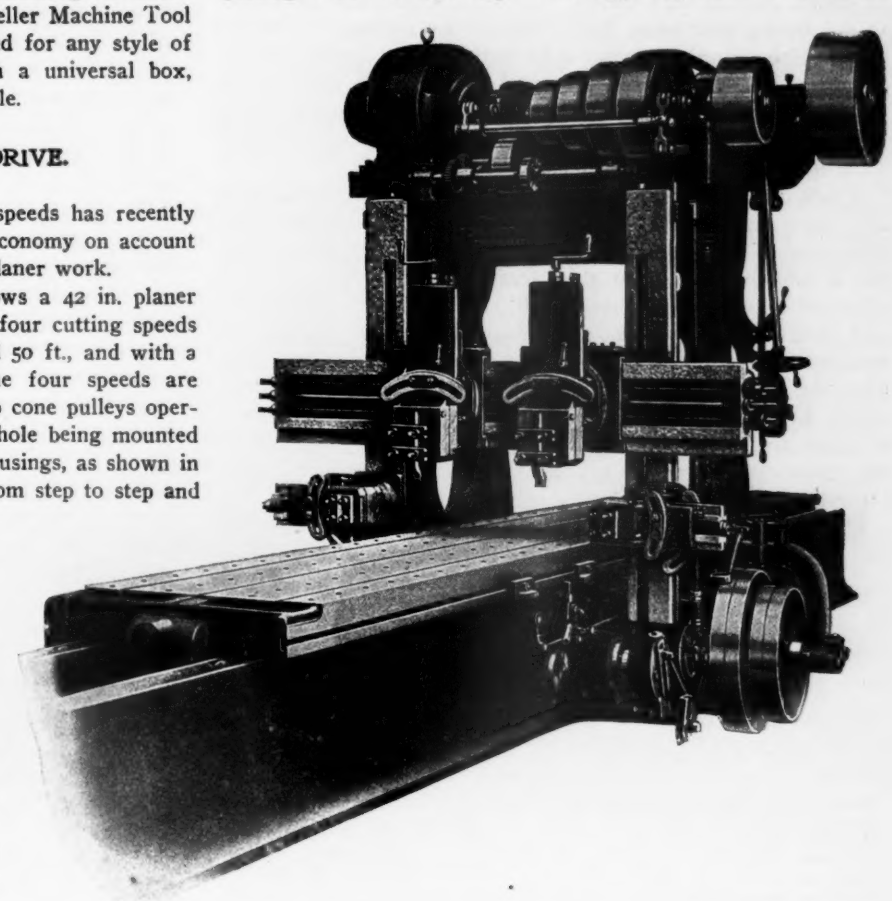
VARIABLE SPEED PLANER DRIVE.

A new planer drive with variable cutting speeds has recently been designed which insures great working economy on account of the flexibility provided for all classes of planer work.

One of the accompanying illustrations shows a 42 in. planer fully equipped with this speed variator with four cutting speeds arranged to provide 20 ft., 30 ft., 40 ft., and 50 ft., and with a constant return speed of about 80 ft. The four speeds are obtained through a pair of opposed four step cone pulleys operated by an endless belt between them, the whole being mounted upon a substantial platform on top of the housings, as shown in the smaller top view. The belt is shifted from step to step and provides a range of speeds calculated to cover the most exacting requirements. These various cutting speeds, with the constant high speed return stroke, insure the greatest working economy.

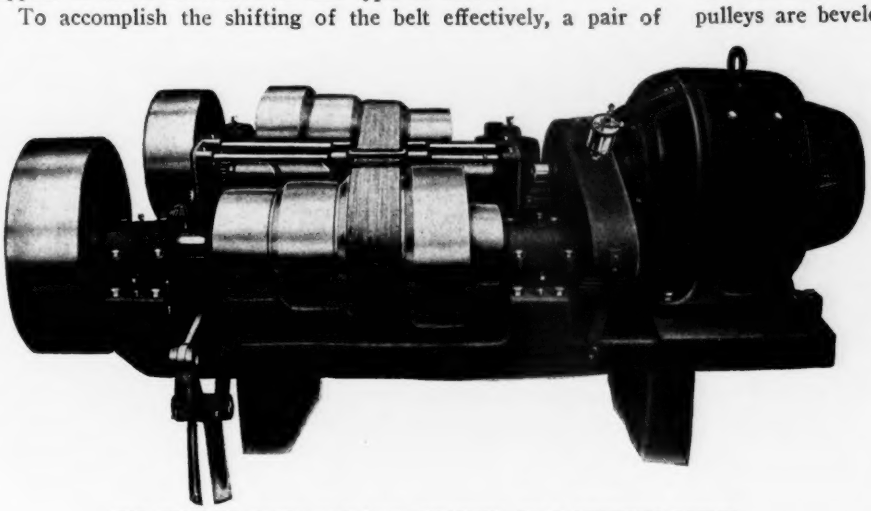
This drive has primarily two distinct and necessary advantages over the old geared drive, in its simplicity of design and freedom from destructive vibration. There are no change gears to break or stick on the shafts, and the usual troubles due to frictions and jaw clutches, together with the splashing of oil over the machine, are eliminated. It is free from the noise and vibration of the gear driven type, which condition becomes worse as the parts are subjected to wear, on account of the excessive speed of the gears. Such vibration ultimately results in inaccuracy to the work being planed and hence unfits the geared drive for accurate planer work. This new speed variator is free from all these defects and insures the smoothest possible work, and its simplicity, efficiency and durability will appeal to those interested in this type of drive.

To accomplish the shifting of the belt effectively, a pair of belt forks are moved alternately along guide rods by means of a pair of cylindrical cams, which revolve alternately through the medium of a set of intermittent gears operated by the hand wheel shown at the rear. One revolution of this wheel shifts the belt from one step to another and a shot pin indicates the complete revolution. The cam rolls have spiral slots milled in their peripheries, each belt fork being moved along the guide rods through the medium of a roller operating in the spiral slots. The relation between the cams and forks is such as to shift the belt from the high step of one cone before placing it on the high step of the opposing cone. The tension



42" X 42" PLANER WITH VARIABLE SPEED MOTOR DRIVE.

of the belt is controlled by the vertical lever, shown at the rear, operating in a radial slot. This lever is of convenient height and, through link connections, operates a pair of bell cranks which serve as levers to slide the driven cone towards the driver, thus slackening the belt. This feature, together with the mechanical belt shifting device and the fact that the steps of the pulleys are beveled on the edge, so as to offer no resistance to the passage of the belt, permits of easily making rapid changes of speed, even though the belt is very wide. After the belt is located for the desired speed, it is brought up tight by moving the hand lever to the point where the tension is sufficient for the work, after which the lever is securely clamped by the binder handle shown. In these operations the driven cone is moved towards the driver, that carries the planer driving belts; thus the tension of the vertical belts is not disturbed when making speed changes, and the danger of their flying off, from becoming loose, is overcome.



TOP VIEW OF SPEED VARIATOR SHOWING BELT SHIFTING DEVICE.

All shafts in the variator are of large diameter, accurately ground and run in massive phosphor-bronze journals perfectly lubricated by the ring or dynamo system of oiling. The journals are supplied with liberal oil wells and return ducts, thereby preventing the oil from escaping and coming in contact with the belts. The bearings are of the ball and socket type, insuring perfect alignment at all times.

The fact that the speeds can be changed without stopping the machine constitutes a valuable feature, for with the old geared type it is necessary to wait until the mechanism slows down to almost a standstill before the clutches or gears could be en-

gaged. With this drive in fact, it is far easier to make the changes while in motion than otherwise. The driving pulleys are perfectly balanced, and have flywheel rims, the momentum of which, even at high speeds, reduces to a minimum all shocks to the driving mechanism due to intermittent cutting and reversing, also insuring a steady, even pull for the cutting stroke. This, coupled with the smoothness of the drive, the good design and accuracy of the planer itself, insures finished work which is free from imperfections, requiring the least, if any, attention from the vise hands in subsequent fitting.

A belt drive is regularly furnished with the variator, the tight and loose pulleys being applied to the rear cone shaft. The drive can be obtained direct from a line shaft, provided same has a sufficient speed, but slow shafts of about 150 r.p.m. require an intermediate or jack shaft. The peculiar construction and design offer the additional advantage that it is a simple matter to convert the belt drive into a motor drive at any time after the machine is installed. For electric drive, as illustrated above, a constant speed motor is required, either of the direct or alternating current type, the motor being direct connected to the variator through spur gearing. A starting box is the only controlling mechanism necessary in this case.

The speed variator and also the planer are manufactured by the American Tool Works Co., Cincinnati, Ohio.

EXHIBITORS AT ATLANTIC CITY.

The exhibition of the Railway Supply Men's Association was even larger and more attractive than in previous years, and reflected great credit on those in charge of its arrangement. Among the firms who had space were the following:

Adams & Westlake Co., Chicago, Ill.
American Arch Co., New York, N. Y.
American Balance Valve Co., Jersey Shore, Pa.
American Brake Shoe & Foundry Co., Mahwah, N. J.
American Car & Foundry Co., New York, St. Louis, and Chicago, Ill.
American Mason Safety Tread Co., Boston, Mass.
American Nut & Bolt Fastener Co., Pittsburg, Pa.
American Steel Foundries Co., Chicago, Ill.
American Vanadium Co., Pittsburg, Pa.
Armstrong Brothers Tool Co., Chicago, Ill.
Baldwin Locomotive Works, Philadelphia, Pa.
Besley & Company, Chas. H., Chicago, Ill.
Bettendorf Axle Co., Davenport, Ia.
Bird & Co., J. A. & W., East Walpole, Mass.
Boyle & Co., Inc., Jno., New York, N. Y.
Bowser & Company, Inc., S. F., Fort Wayne, Ind.
Brill Company, J. G., Philadelphia, Pa.
Brown Auto Hose Coupling Co., Cleveland, O.
Buckeye Steel Castings Co., Columbus, O.
Buffalo Brake Beam C., New York, N. Y.
Burroughs Adding & Listing Machine Co., Detroit, Mich.
Butler Draw Bar Attachment Co., Cleveland, O.
Carborundum Company, Niagara Falls, N. Y.
Carnegie Steel Company, Pittsburg, Pa.
Carter Iron Co., Pittsburg, Pa.
Celfor Tool Co., Chicago, Ill.
Central Electric Co., Chicago, Ill.
Chase & Company, L. C., Boston, Mass.
Chicago Car Heating Co., Chicago, Ill.
Chicago Railway Equipment Co., Chicago, Ill.
Chicago Steel Car Co., Chicago, Ill.
Chicago Varnish Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Car Specialty Co., Cleveland, O.
Clow & Sons, James B., Chicago, Ill.
Coe Brass Mfg. Co., Ansonia, Conn.
Commercial Acetylene Co., New York, N. Y.
Commonwealth Steel Co., St. Louis, Mo.
Consolidated Car Heating Co., Albany, N. Y.
Consolidated Railway Electric Lighting & Equipment Co., New York, N. Y.
Cooper-Hewitt Electric Co., New York, N. Y.
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
Curtain Supply Co., Chicago, Ill.
Damascus Brake Beam Co., Cleveland, O.
Davis-Bournonville Co., New York, N. Y.
Dearborn Drug & Chemical Works, Chicago, Ill.
D. P. Company, New York, N. Y.
Detroit Hoist & Mach. Co., Detroit, Mich.
Detroit Lubricator Co., Detroit, Mich.
Dickinson, Paul, Incorporated, Chicago, Ill.
Dixon Crucible Company, Joseph, Jersey City, N. J.
Dressel Lamp Works, New York, N. Y.
Duff Manufacturing Co., Pittsburgh, Pa.
Duntley Manufacturing Co., Chicago, Ill.
Edison Storage Battery Co., New York, N. Y.
Edwards Company, O. M., Syracuse, N. Y.
Electric Hose & Rubber Co., Wilmington, Del.
Electric Storage Battery Co., Philadelphia, Pa.
Faessler Mfg. Co., J., Moberly, Mo.
Fairbanks Company, New York, N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Flannery Bolt Co., Pittsburg, Pa.
Forsyth Brothers Co., Chicago, Ill.
Foster, Walter H., New York, N. Y.
Franklin Manufacturing Co., Franklin, Pa.
Franklin Railway Supply Co., New York, N. Y.
Frost Railway Supply Co., Detroit, Mich.
Galena Signal Oil Co., Franklin, Pa.
Garlock Packing Co., Palmyra, N. Y.
General Electric Co., Schenectady, N. Y.
General Railway Supply Co., Chicago, Ill.
Gilbert & Barker Mfg. Co., Springfield, Mass.
Gold Car Heating & Lighting Co., New York, N. Y.
Goldschmidt Thermit Co., New York, N. Y.
Gould Coupler Co., New York, N. Y.
Greene, Tweed & Co., New York, N. Y.
Grip Nut Co., Chicago, Ill.
Hale & Kilburn Mfg. Co., Philadelphia, Pa.
Hammett, H. G., Troy, N. Y.
Harlan & Hollingsworth Corporation, Wilmington, Del.
Harrington, Edwin, Son & Co., Inc., Philadelphia, Pa.
Heywood Bros. & Wakefield Co., Philadelphia, Pa.
Hobart Allfree Co., Chicago, Ill.
Hunt-Spiller Manufacturing Corporation, South Boston, Mass.
Hutchins Car Roofing Co., Detroit, Mich.
International Correspondence Schools, Scranton, Pa.
Independent Pneumatic Tool Co., Chicago, Ill.
Jenkins Brothers, New York, N. Y.
Johns-Manville Co., H. W., New York, N. Y.
Joliet Railway Supply Co., Joliet, Ill.
Joyce Cridland Co., Dayton, O.
Kelly-Arnold Mfg. Co., Wilkes-Barre, Pa.
Kerite Insulated Wire & Cable Co., New York, N. Y.
Kilbourne & Jacobs Mfg. Co., Columbus, O.
Lackawanna Steel Co., New York, N. Y.
Landis Machine Company, Waynesboro, Pa.
Landis Tool Co., Waynesboro, Pa.
Linde Air Products Co., Buffalo, N. Y.
Love Brake Shoe Co., Chicago, Ill.
Lunkenheimer Company, Cincinnati, O.
Lupton's Sons Co., David, Philadelphia, Pa.
McConway & Torley Co., Pittsburg, Pa.
McCord & Company, Chicago, Ill.
Manning, Maxwell & Moore, New York, N. Y.
Midvale Steel Co., Philadelphia, Pa.
Millburn Co., Alexander, Baltimore, Md.
Modoc Soap Co., Philadelphia, Pa.
Molleson Co., Geo. E., New York, N. Y.
Moran Flexible Steam Joint Co., Louisville, Ky.
Nathan Mfg. Co., New York, N. Y.
National-Acme Mfg. Co., Cleveland, O.
National Lock Washer Co., Newark, N. J.
National Malleable Casting Co., Cleveland, O.
National Railway Devices Co., Chicago, Ill.
Newhall Engineering Co., Geo. M., Philadelphia, Pa.
New York Air Brake Co., New York, N. Y.
Nichols & Brother, Geo. P., Chicago, Ill.
Niles-Bement-Pond Co., New York, N. Y.
Norton Company, Worcester, Mass.
Norton, Inc., A. O., Boston, Mass.
Okonite Co., New York, N. Y.
Pantasote Co., New York, N. Y.
Parkesburg Iron Company, Parkesburg, Pa.
Pilliod Brothers, Toledo, O.
Pilliod Company, Swanton, O.
Pittsburg Equipment Co., Pittsburg, Pa.
Pressed Steel Car Co., Pittsburg, Pa.
Pugh, Job T., Philadelphia, Pa.
Railway Materials Co., Chicago, Ill.
Rapp Company, John W., New York, N. Y.
Restein Company, Clement, Philadelphia, Pa.
Revolute Machine Co., New York, N. Y.
Rockwell Furnace Co., New York, N. Y.
Royersford Foundry & Machine Co., Inc., Royersford, Pa.
Safety Car Heating & Lighting Co., New York, N. Y.
Scullin-Gallagher Iron & Steel Co., St. Louis, Mo.
Scully Steel & Iron Co., Chicago, Ill.
Sellers & Company, Wm., Incorporated, Philadelphia, Pa.
Spencer Turbine Cleaner Co., Hartford, Conn.
Sprague Electric Co., New York, N. Y.
Standard Coupler Co., New York, N. Y.
Standard Steel Car Co., New York, N. Y.
Standard Steel Works Co., Philadelphia, Pa.
Stoever Foundry & Mfg. Co., New York, N. Y.
Storrs Mica Co., Owego, N. Y.
Strong, Carlisle, Hammond Co., Cleveland, O.
Symington Co., T. H., Baltimore, Md.
Talmage Mfg. Co., Cleveland, O.
Taylor Mfg. Co., James L., Bloomfield, N. J.
Templeton Kenly & Co., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Titan Steel Castings Co., Newark, N. J.
Toledo Pipe Threading Machine Co., Toledo, O.
Trenton Malleable Iron Co., Trenton, N. J.
Underwood & Co., H .B., Philadelphia, Pa.
Union Draft Gear Co., Chicago, Ill.
Union Fibre Co., Winona, Minn.
Union Mfg. Co., New Britain, Conn.
Union Spring & Mfg. Co., Pittsburg, Pa.
U. S. Metal & Mfg. Co., New York, N. Y.
U. S. Metallic Packing Co., Philadelphia, Pa.
Vanadium Metals Co., Pittsburg, Pa.
Walworth Mfg. Co., Boston, Mass.
Ward Equipment Co., New York, N. Y.
Watson-Stillman Co., New York, N. Y.
Waugh Draft Gear Co., Chicago, Ill.
Welsbach Company, Gloucester, N. J.
West Disinfecting Co., Inc., New York, N. Y.
Western Railway Equipment Co., St. Louis, Mo.
Westinghouse Air-Brake Co., Pittsburg, Pa.
Westinghouse Automatic Air & Steam Coupler Co., St. Louis, Mo.
Westinghouse Electric Mfg. Co., Pittsburg, Pa.
Westinghouse Machine Co., The, Pittsburg, Pa.
Wheel Truing Brake Shoe Co., Detroit, Mich.
Whipple Supply Co., New York, N. Y.
Williams & Co., J. H., Brooklyn, N. Y.
Wood, Guilford S., Chicago, Ill.
Wright Wrench Mfg. Co., Canton, O.
Yale & Towne Mfg. Co., New York, N. Y.

BOOK NOTES.

Correction.—"The Practice and Theory of the Injector," by Kneass, $1.50, which appeared in this column in the last issue, was through error entitled: "Practice and Theory of the Indicator."

Polytechnic Engineer, May, 1910. 144 pages. Cloth. Published annually by the Polytechnic Institute of Brooklyn, 85 Livingston street, Brooklyn, N. Y. Subscription price, $1.50 per copy.

The aim of this book has been to present essentially a Polytechnic publication that will be of interest and value to the undergraduates and their friends in the scientific world and most of the articles are by Polytechnic Institute men. Some very good research work has been presented in permanent form; some of the articles are: Negative Track Feeders, Experiments on the Case-Hardening of Steel by Gases, Train Resistance Formulas and Speed-Time Relations, Gyration Stresses in Shafts, and Some Neglected Branches of Engineering, which is by G. M. Basford.

Metal Spinning. By C. Tuells and Wm. A. Painter. 38 page pamphlet, 6 x 9 in. Illustrated. Published by the Industrial Press, 49 Lafayette street, New York. Price, 25 cents.

This booklet is No. 57 of "Machinery's" Reference Series, and contains some interesting and valuable information for metal workers.

PERSONALS.

J. D. Maupin, general foreman of the Trinity & Brazos Valley Railway at Teague, Tex., has been appointed master mechanic.

Geo. S. McKee, superintendent of motive power and car equipment on the Mobile & Ohio Railroad, retired June 1.

George S. Goodwin has been appointed assistant mechanical engineer of the Chicago, Rock Island & Pacific Railway, with office at Silvis, Ill.

E. J. Robertson has been appointed superintendent car department of the Minneapolis, St. Paul & Sault Ste. Marie Railway, succeeding I. G. Pool, deceased.

H. H. Hillberry has been appointed master mechanic on the Toledo division of the Pennsylvania Lines west of Pittsburgh, at Toledo, O., succeeding Mr. McDonnell, transferred.

George H. Burton, assistant master mechanic of the Northern Central Railway, has been transferred to Renovo, Pa., as a result of the abandonment of the shops at Mt. Vernon.

W. F. Kapp, superintendent of shops and machinery of the Richmond, Fredericksburg & Potomac R. R., at Richmond, Va, has had his title changed to superintendent of motive power.

C. H. Kadie, master mechanic of the Southern Railway at Charleston, S. C., has been transferred to Alexandria with the same title, succeeding Mr. Sasser, transferred.

G. E. Sisco, foreman of the Allegheny shops on the northwest system of the Pennsylvania Lines west of Pittsburgh, has been promoted to assistant master mechanic at Allegheny, succeeding Mr. Hillberry, promoted.

F. V. McDonnell, master mechanic of the Pennsylvania Lines west of Pittsburgh, at Toledo, O., has been transferred to Mahoningtown, Pa., with the same title, succeeding Mr. Reese, promoted.

E. C. Sasser, master mechanic of the Southern Railway at Alexandria, Va., has been appointed master mechanic at Spencer, N. C., succeeding W. F. Kaderly, resigned to go to another company.

M. Flanagan, foreman of the machine department of the Chesapeake & Ohio Railroad at Richmond, Va., has been appointed master mechanic of the Richmond division, with office at Richmond.

W. V. Fountain, master mechanic for the Shreveport, Houston & Gulf R. R., has resigned to accept service in a similar capacity with the Nacogdoches & Southeastern R. R., with headquarters at Nacogdoches, Tex.

O. P. Reese, master mechanic of the Pennsylvania Lines at Mahoningtown, Pa., has been promoted to assistant engineer of motive power on the Northwest system of the Pennsylvania Lines, at Ft. Wayne, Ind., succeeding T. R .Cook, transferred.

Ben Johnson has been appointed superintendent of motive power of the United Railways of Havana and of the Havana Central Railroad with office at Havana, Cuba, succeeding Mr. Charles J. Thornton, resigned.

I. G. Pool, for twenty-two years an employee of the Minneapolis, St. Paul & Sault St. Marie Railway, and for the last few years superintendent of the car department, died at his home in Minneapolis on June 6, aged 66 years.

T. R. Cook, assistant motive power engineer at Ft. Wayne, Ind., has been appointed master mechanic on the Pittsburgh and Cleveland division of the Pennsylvania Lines west of Pittsburgh, at Wellsville, Ohio, succeeding A. C. Davis, resigned.

H. S. Needham, motive power inspector at Columbus, O., has been appointed assistant engineer of motive power on the southwest system of the Pennsylvania Lines west of Pittsburgh, at the same place, succeeding C. D. Young, transferred.

D. Kavanaugh, district storekeeper of the Chicago, Rock Island & Pacific Railway at Silvis, Ill., has been appointed general storekeeper of that railway at the same place, succeeding Mr. Reed, promoted to another department.

William A. Summerhays, assistant general storekeeper of the Illinois Central Railroad at Chicago, has been appointed general storekeeper of that company, the Indianapolis Southern Railroad and the Yazoo & Mississippi Valley Railroad, with office at Chicago, succeeding John M. Taylor, resigned.

C. D. Young, assistant engineer of motive power on the southwest system of the Pennsylvania Lines west of Pittsburgh, at Columbus, O., has been promoted to assistant engineer in the office of the general superintendent of motive power of the lines west of Pittsburgh, at Pittsburgh, Pa.

A. R. Ayers, whose appointment as mechanical engineer of the Lake Shore & Michigan Southern was recently announced in these columns, has been appointed also mechanical engineer of the Chicago, Indiana & Southern Railroad and the Indiana Harbor Belt Railroad.

E. J. Searles has been appointed assistant to J. D. Harris, general superintendent of motive power of the Baltimore & Ohio Railroad, with office at Baltimore, Md. Mr. Searles was engineer of motive power of the Baltimore & Ohio at Pittsburgh from 1902 to 1904, and since 1904 he has been engaged in the railway supply business.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Boiler Tube Cleaner.—The William B. Pierce Co., 327 Washington St., Buffalo, N. Y., is issuing a pamphlet on the Dean boiler tube cleaner, showing why users are enthusiastic.

Air Compressors.—The Ingersoll-Rand Co., 11 Broadway, New York, has recently sent out new catalogues describing class "O C" duplex Corliss steam driven and class "O" duplex steam driven compressors.

Tate Flexible Staybolts.—The Flannery Bolt Co., Pittsburg, Pa., has sent out a very attractive catalog for 1910, describing and illustrating the Tate flexible staybolts and all tools required for their installation.

Gas and Gasoline Engines.—The Turner-Frick Mfg. Co., Sharon, Pa., are sending out an illustrated catalog describing its four-cycle vertical three-cylinder gas engines for power plant work up to 325 h.p. capacity.

Snow Plows.—A very well illustrated catalog for 1910, describing the Russell snow plow and flangers for steam railroads, has been issued by the Russell Car and Snow Plow Co., Ridgeway, Pa.

Fibre Conduit.—H. W. Johns-Manville Co., 100 William street, New York City, has sent out a small booklet describing the J. M. fibre, moulded conduit furnished in sections 54 in. long and ranging from 2 to 4 in. in diameter.

Portland Cement.—The Alpha Portland Cement Co., Easton, Pa., is issuing a very attractive catalog descriptive of its product, which includes some excellent examples of recent concrete work, both for railroads or industrial and municipal concerns.

Machine Tools.—A new catalog has recently been issued by the Murchey Machine & Tool Co., Detroit, Mich., which illustrates and describes a number of machines and tools for rapid machine work, including the latest automatic nipple machines, automatic dies and revolving, fitting and valve chucks.

Gas Analysis Instruments.—The Carb-Ox Co., Rogers Park, Chicago, has recently issued a new catalog describing gas analysis instruments, appliances used for boiler testing and other specialties. This apparatus is suitable for power plants using coal, oil, gas or any other fuel.

Lifting Magnets.—A very interesting little circular has recently been issued by the Cutler-Hammer Clutch Co., Milwaukee, Wis., which shows a large and clear sectional view of a new lifting magnet, with a good description; and also other views showing the application to all classes of work.

Bartley Nut and Bolt Fasteners.—Catalog No. 6 bearing the above title has recently been issued by the American Nut and Bolt Fastener Co., Pittsburg, Pa. It illustrates the application of all the various forms of fasteners and nut locks and includes a complete price list.

Coal Crushers.—A very clearly and attractively illustrated Bulletin No. 39 is being sent out by the Jeffrey Mfg. Co., Columbus, Ohio, describing in detail their coal and coke crushers and giving complete tables of dimensions and capacities. The crusher rolls are made up of renewable sections.

Ball Bearings for Car Journals.—The Hess-Bright Mfg. Co., Philadelphia, Pa., has just issued an interesting circular describing and illustrating by means of a sectional view a correct application of ball bearings to car journals.

Grinding Machines.—A very attractive catalog has recently been issued by the Landis Tool Co., Waynesboro, Pa., describing a variety of grinding machines for all classes of work. It is completely illustrated and includes sectional views with dimensions for all their various shapes and sizes of grinding wheel carried in stock.

Curtis Turbine Installations.—An attractive catalog, No. 4732, has recently been issued by the General Electric Co., Schenectady, N. Y., bearing the above title and containing upwards of fifty illustrations of installations of Curtis steam turbine generators from 25 kw. up to 12,000 kw. Power plant managers will find this very interesting.

Friction Draft Gear.—The Union Draft Gear Co., Monadnock Block, Chicago, has recently issued a new catalog illustrating the Cardwell friction draft gear. This catalog is very well illustrated and includes the results of a number of tests of this draft gear.

Work Done.—Westinghouse, Church, Kerr & Co., engineers and constructors, 10 Bridge St., New York City, have issued a very nicely illustrated catalog with the above title, containing 82 pages and describing the entire range of engineering and construction service which they have completed. This work includes contracts in every part of the United States, Southern Canada and Mexico, in connection with railroad terminals, electrical equipment plants, etc.

Electric Hardening Furnace.—The General Electric Co., Schenectady, N. Y., has recently issued Bulletin No. 4737 illustrating and describing its electric hardening furnace for hardening or tempering tool steel. This furnace is very economical and constitutes a marked improvement over all previous methods. The same company has also issued Bulletin No. 4738 describing belt driven revolving armature alternators. Bulletin No. 4736, describing the lightning arresters for alternating and direct current high voltage circuits, will be of interest to central station managers, as well as No. 4741, on luminous arc lamps for direct current multiple circuits.

Electric Fixtures.—A very artistic and attractive catalog of 85 pages, bearing the above title, has recently been issued by the Safety Car Heating and Lighting Co., 2 Rector street, New York. No expense has been spared in illustrating the design of these fixtures, as well as the character of the workmanship, which the company uniformly insists upon. It has been the aim also to show a comprehensive collection from the great variety of designs representing all the principal schools of art. Special attention is given to the photometric tests and the designs are worked out in every case to insure an interchangeability of parts.

Locomotive Valve Gear.—A new 28-page illustrated catalog has recently been issued by the Hobart-Allfree Company, 1380 Old Colony Building, Chicago, Ill., which describes its locomotive cylinders and new design of valve gear. This new gear is the radial type, located entirely outside of the locomotive frames and does not require links. It incorporates an auxiliary exhaust valve in the cylinders, controlling the point of compression, which is said to greatly improve the steam distribution.

NOTES.

Wisconsin Engine Company.—The above company announces that George B. Foster has been appointed its Chicago sales manager, with offices in the Fisher Building, Chicago.

Triumph Electric Co.—The healthy condition of the electric trade is well indicated by the announcement from the above company, of Cincinnati, O., that during the past few weeks they have sold an unusually large number of large size machines, as well as a normal amount of smaller equipment. They report business to be excellent in every department.

Reliance Electric & Engineering Company.—The above company, of Cleveland, Ohio, announces that hereafter its armature shifting type of variable speed motor will be known as the Reliance Adjustable Speed Motor instead of the Lincoln Variable Speed Motor as formerly, to comply with present standard terms adopted by the American Association of Electric Motor Manufacturers and also to avoid confusion with the Lincoln Electric Company of the same city.

Joseph Dixon Crucible Company.—It is announced that at the annual meeting of the stockholders of this company, the old board, consisting of Geo. T. Smith, William Murray, William H. Corbin, Edward L. Young, Geo. E. Long, William H. Bumsted and Harry Dailey, were unanimously re-elected, and the board of directors re-elected the former officers, namely, Geo. T. Smith, president; William H. Corbin, vice-president; Geo. E. Long, treasurer; Harry Dailey, secretary; J. H. Schermerhorn, assistant treasurer and assistant secretary. William H. Corbin was also re-elected as counsel.

Lucius I. Wightman, for the past six years advertising manager for the Ingersoll-Rand Co., 11 Broadway, New York, announces that he has resigned his position, effective August 1st, and that he will open an office in New York City as an independent specialist in machinery advertising, handling the accounts of manufacturers of machinery and engineering products. To his long experience in managing one of the largest advertising accounts and publicity departments in the machinery field, he joins a prior experience of years in practical mechanical and electrical engineering, construction work, and machine design and manufacture.

The Bettendorf Axle Co.—Wm. P. Bettendorf, president of the above company, Davenport, Iowa, died June 3, at his home, at the age of 53 years, as the result of cancer of the bowels. Mr. Bettendorf was generally recognized by those who knew him in his work as a man of remarkable inventive and mechanical ability. His inventions were marked by great originality, and have established merit. His methods of manufacture contributed hardly less to this success than the mechanical design of the articles themselves. The successful building up of a great railway industry at a point so remote from the producing centers of the material used, shows that business ability was combined with that of inventor and designer. His first railway device was a pressed-steel brake beam, of which but few were manufactured. He next turned his attention to I-beam bolsters and underframing for cars. Still later he invented the cast steel side frame for trucks, in which the journal boxes and frame are cast integrally in one piece. The success of his business is too recent to need to have attention called to it.

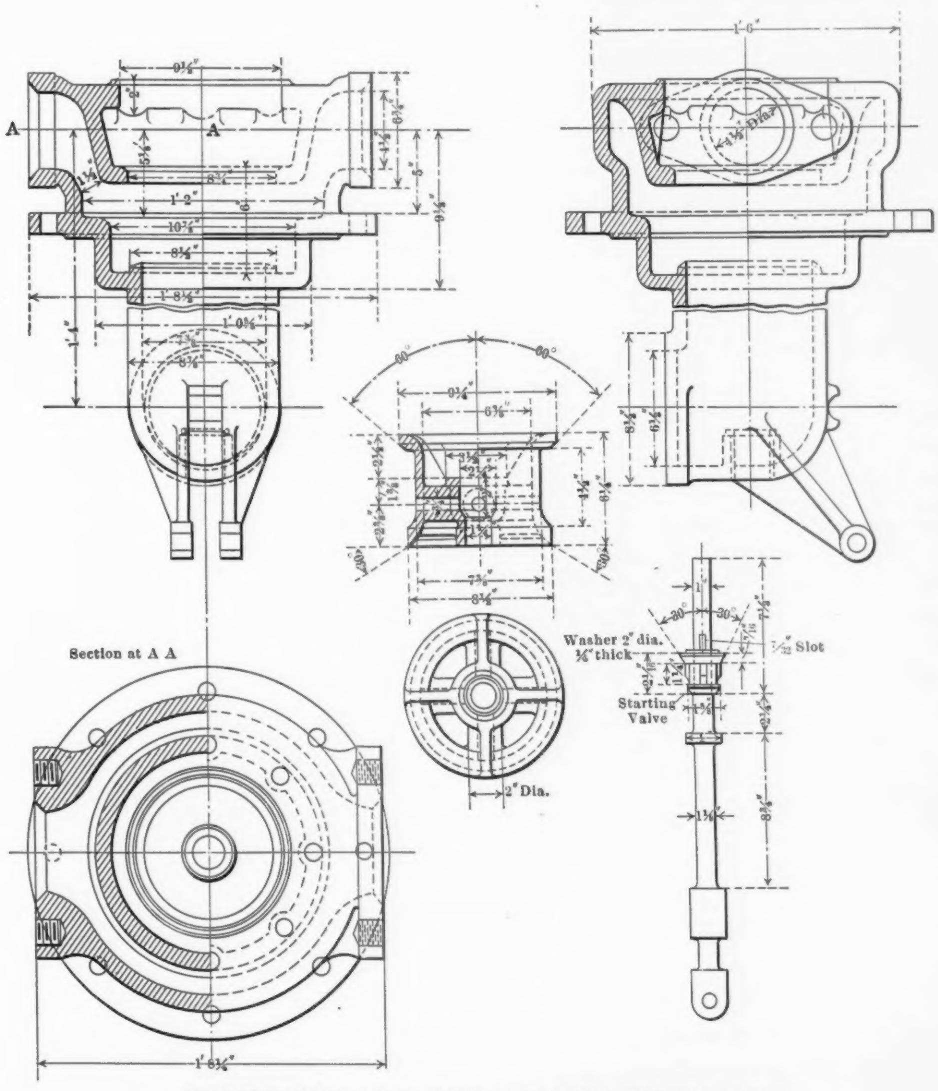
SOME DETAILS OF THE ARTICULATED COMPOUND LOCOMOTIVE BUILT AT THE SHOPS OF THE CANADIAN PACIFIC RAILWAY.

On page 81 of the March, 1910, issue of this journal appeared a very complete and interesting description of the experimental Mallet locomotive recently built at the Angus shops of the Canadian Pacific Railway. That article considered the essential features of the design and gave the results of the tests made on it, also mentioning briefly a number of the more interesting details. The design of many of these features is entirely original and in some cases unique, and we are now able to give illustrations of a number of the more prominent ones.

THROTTLE VALVE.

Reference to the boiler drawing on page 82 will show that the throttle valve chamber is secured outside of the boiler shell and connects to a cast iron dry pipe from the dome, located just ahead of it, by means of an interior extension. From the throttle valve chamber the steam is carried to the superheater through two external pipes, one on either side, which are very heavily lagged to reduce condensation.

This chamber is of cast iron and rests on a brass ball ring having a ground joint with the plate secured to the boiler shell. The throttle valve proper is, of course, of the balanced type, there being a large steam chamber above it, admission to which is obtained through the hollow center of the valve. It is 9¼ in. in diameter at the top and 8½ in. at the bottom. A starting valve arrangement is included consisting of a small valve secured to the stem which seats in the center of the main valve when the throttle is closed. The main throttle is not fastened to the stem but is lifted by a lug or boss which comes in contact with the bottom of the main valve. Before this occurs, however, the small starting valve is lifted ½ in. and gives an admission through four ¾ in. ports in the body of the main valve. These serve to fill the steam pipes, superheater, etc., and to some extent equalize the pressure so that when the main valve is opened there is not a sudden large draft of steam.

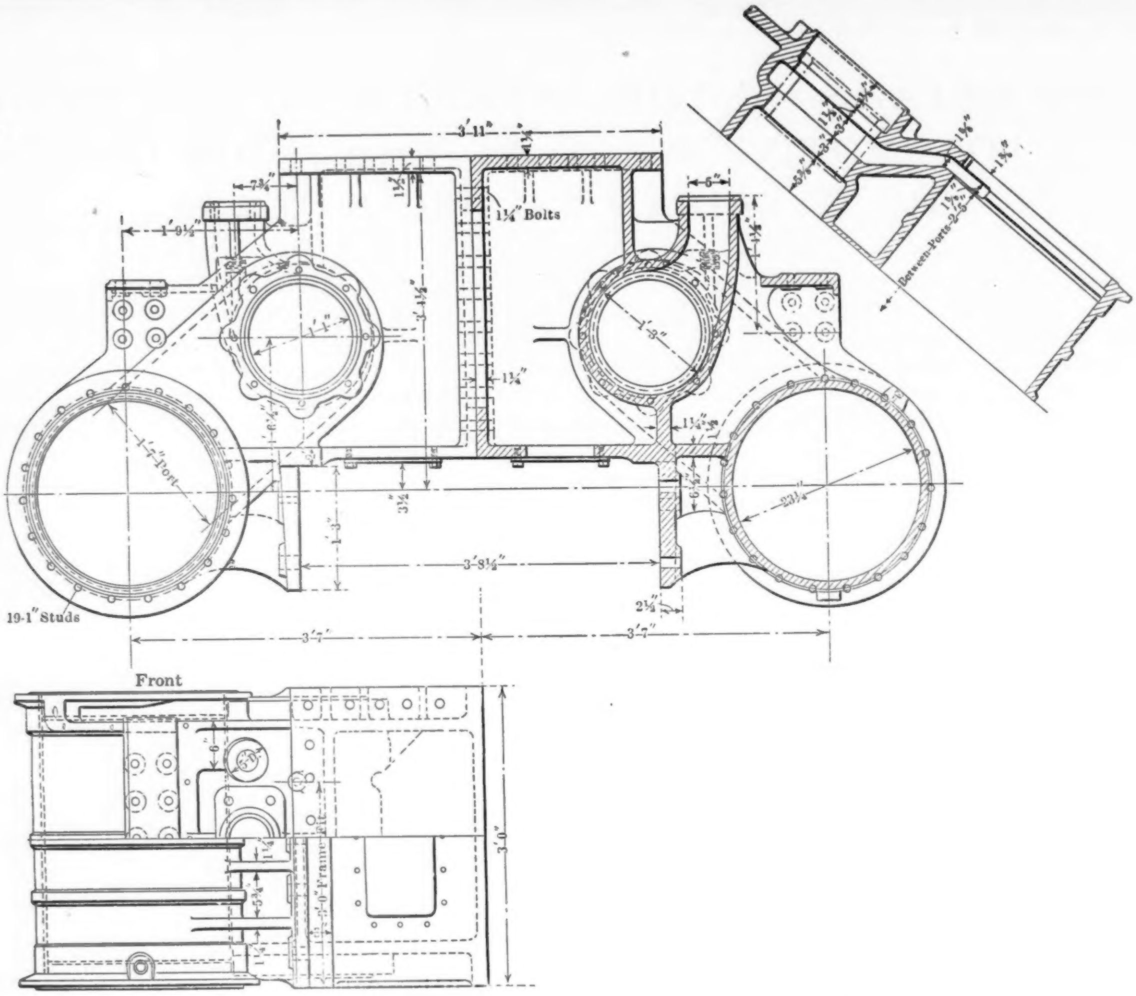


THROTTLE VALVE WITH SMALL AUXILIARY STARTING VALVE.

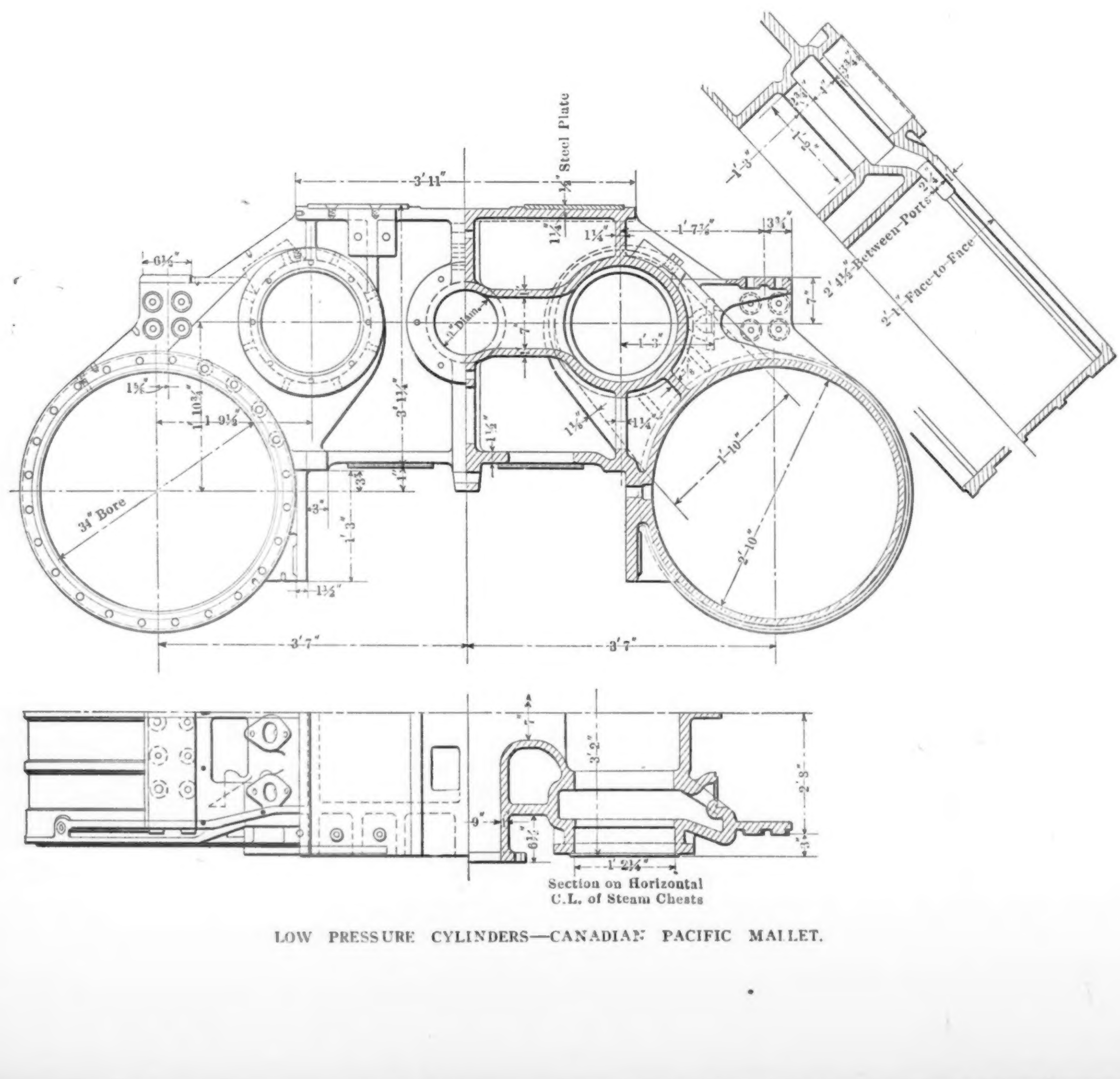
Reference to the illustration will show the detail construction of these parts and also the arrangement for the bell crank, which is connected to the throttle lever in the cab.

CYLINDERS.

Both sets of cylinders are cast independent of the saddle proper but are joined on the center line in the usual manner. Piston valves are used, the high pressure being inside admission and the

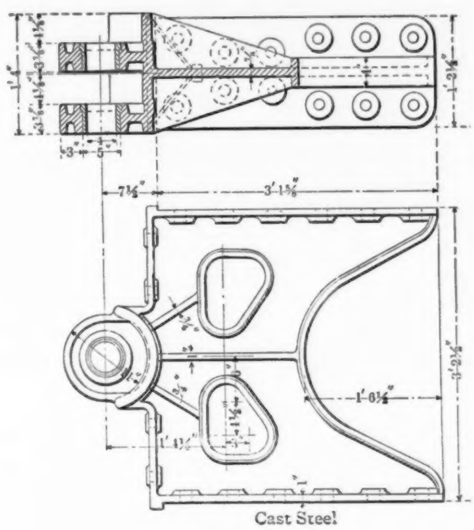


HIGH PRESSURE CYLINDERS—CANADIAN PACIFIC MALLET.



LOW PRESSURE CYLINDERS—CANADIAN PACIFIC MALLET.

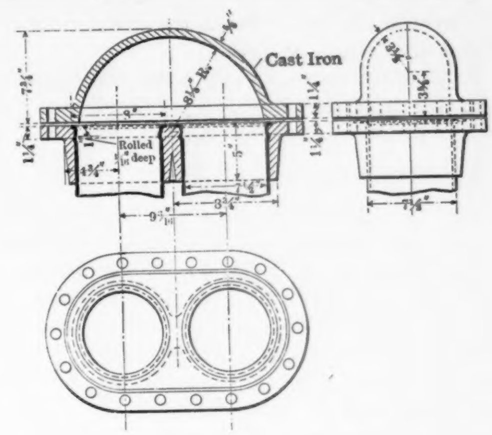
low pressure outside. The design of both of these cylinders is clearly shown in the illustration and follow, as far as possible, the standard arrangement of this road. The valve chambers are set inside over the frames, the valves being operated by a rocker, the same as on simple engines on this road. A steam pipe from the superheater extends down outside of the boiler and connects to an extension from the top of the valve chest of the high-pressure cylinders. The exhaust is all through the front head of the valve chamber, the piston valves being of the hollow type. A cast steel saddle secures the high-pressure cylinders to the boiler. Inasmuch as this connection is made to a point on the barrel which is under pressure, great care was used to prevent any possibility of the bolts working loose. The saddle is secured to the barrel by 1¼ in. bolts driven into taper holes reamed from the pressure side. The connection to the cylinders is on a flat surface 3 ft. 11 in. wide by 3 ft. long and is made by 32 1⅛ in. bolts.



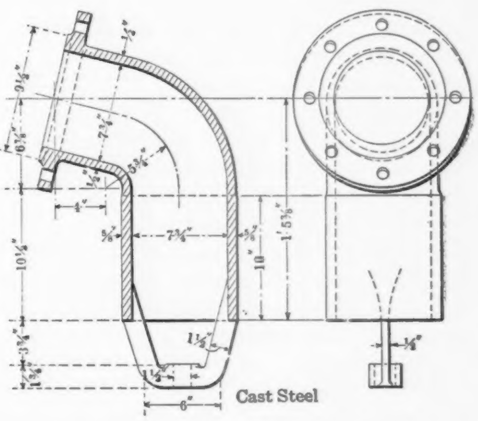
HINGE CASTING.

There is, of course, no connection between the boiler and the low-pressure cylinders, although a small saddle or steadying casting is secured to the barrel at this point and slides on a steel plate on the top of the cylinders. This, however, is not expected to carry any weight.

The relative arrangement of the valve chambers and cylinders is the same as on the high pressure but the exhaust passage is carried from the center of the steam chest to a 9 in. opening in the center of the cylinder casting on a line with the valve chambers. This passage is closed by a plate at the rear and continued by an elbow at the front to the exhaust pipe.

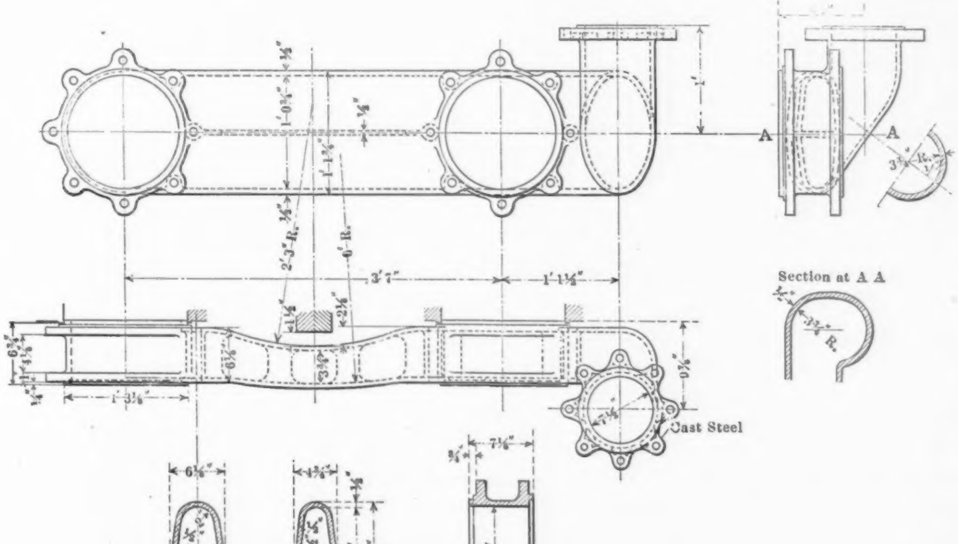


RETURN BEND ON RECEIVER PIPE.



SWIVEL ELBOW IN RECEIVER LINE.

A study of the design of these cylinders will show the care that has been used to secure lightness and simplicity. At first sight it might appear that the flanges for the frame connections were too light but when it is remembered that the frames are slabbed to 15 in. in depth by 3 in. wide at this point and the hinge or articulated joint castings which connect the two groups together



RECEIVER HEADER ON HIGH PRESSURE CYLINDERS

are secured between the frames below the cylinders, it is evident that this flange is of ample strength.

One of the illustrations shows this hinge casting, which is in duplicate for the front and rear groups, simply being reversed in order to get the proper bearings for the lugs.

RECEIVER AND EXHAUST PIPING.

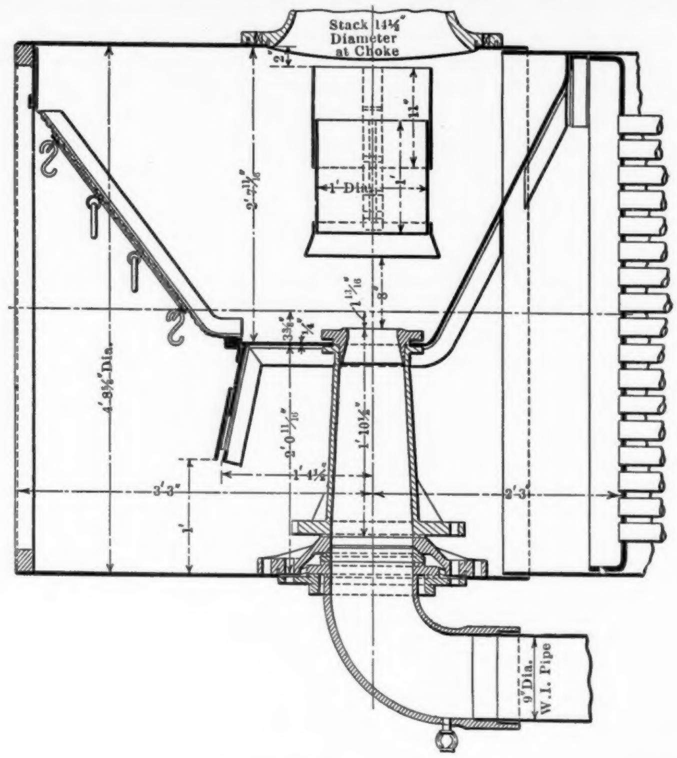
A cast steel header connecting on the front of both valve chambers of the high pressure cylinders carries the exhaust from these cylinders to the receiver pipe located on the left side of the locomotive. One of the illustrations shows the detail of this header. The steam chest heads are secured outside and it really forms part of the cylinder, although, of course, removable, the studs holding the heading being attached directly to the cylinder and passing through the header. The receiver consists of a 7 in. wrought iron pipe extending outward and upward from this header for about 6 ft. It then connects to a return bend and is continued downward and inward to an elbow pipe, located directly over the pin connecting the two groups. At this point there is a packed swivel joint, being the only one on the locomotive. This joint is made between this elbow pipe and the header secured to the rear of the low pressure cylinders, extending from the valve chambers in a manner very similar to the high pressure header.

One of the illustrations shows the detail of this connection. The cast steel elbow pipe has a straight finished surface, its lower end extending down through the gland on the low pressure header. The packing is alternate wedges of cast iron and white metal, there being four pairs in the set. The steam pressure would tend to force the elbow pipe out of the gland and a loop has been cast at its bottom which extends down and swivels around a 1¼ in. bolt in the bottom of the header.

From the exhaust passages in the low pressure cylinders the steam is carried to the exhaust pipe in the front end through a 9 in. pipe arranged with a swivel joint at both ends. The illustration of the front end shows the construction of the joint at that point and the other joint of the same arrangement is formed on top of an elbow pipe that extends out from the exhaust passage in the low-pressure cylinder. Both of these joints are arranged to swivel, having a ball seat, and are also permitted a longitudinal movement to the small extent required by the design,—only ⅜ of an inch. The arrangement consists of a brass ball ring having a ground joint connection on its lower surface, the whole elbow pipe construction being held together by ten springs of 200 lbs. capacity each, or a total of 2,000 lbs. In this manner a slip-joint in the exhaust line was made unnecessary.

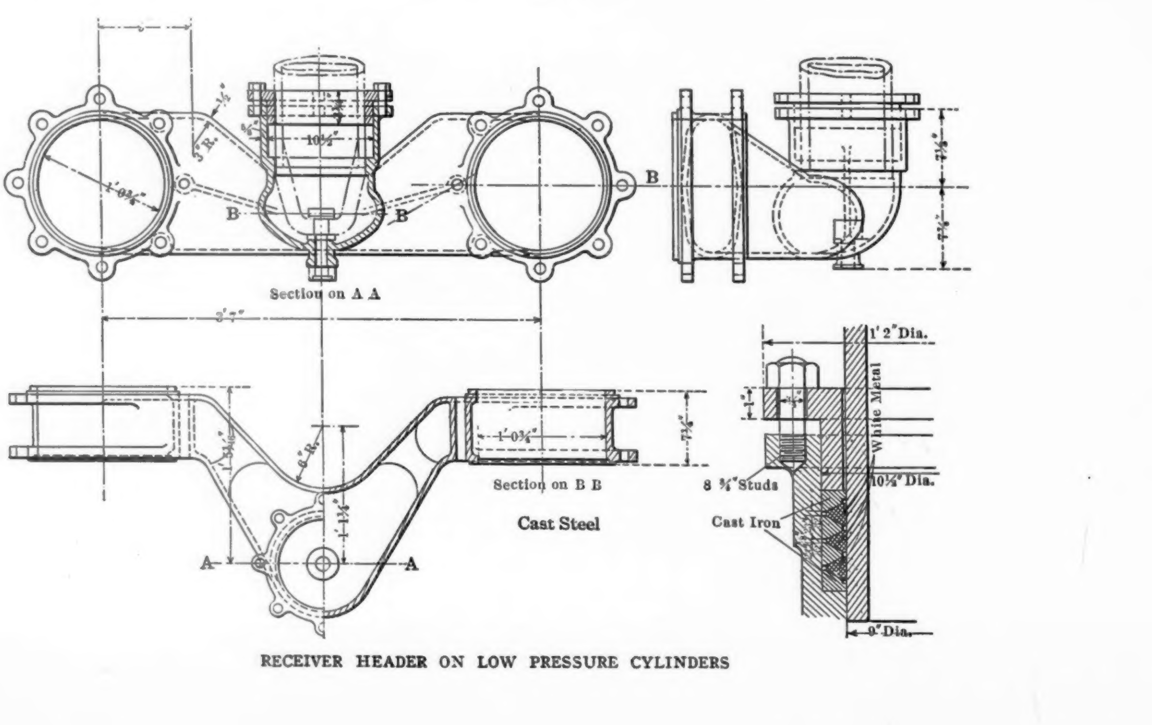
STEAM REVERSE GEAR.

This gear is entirely original in many of its features and in

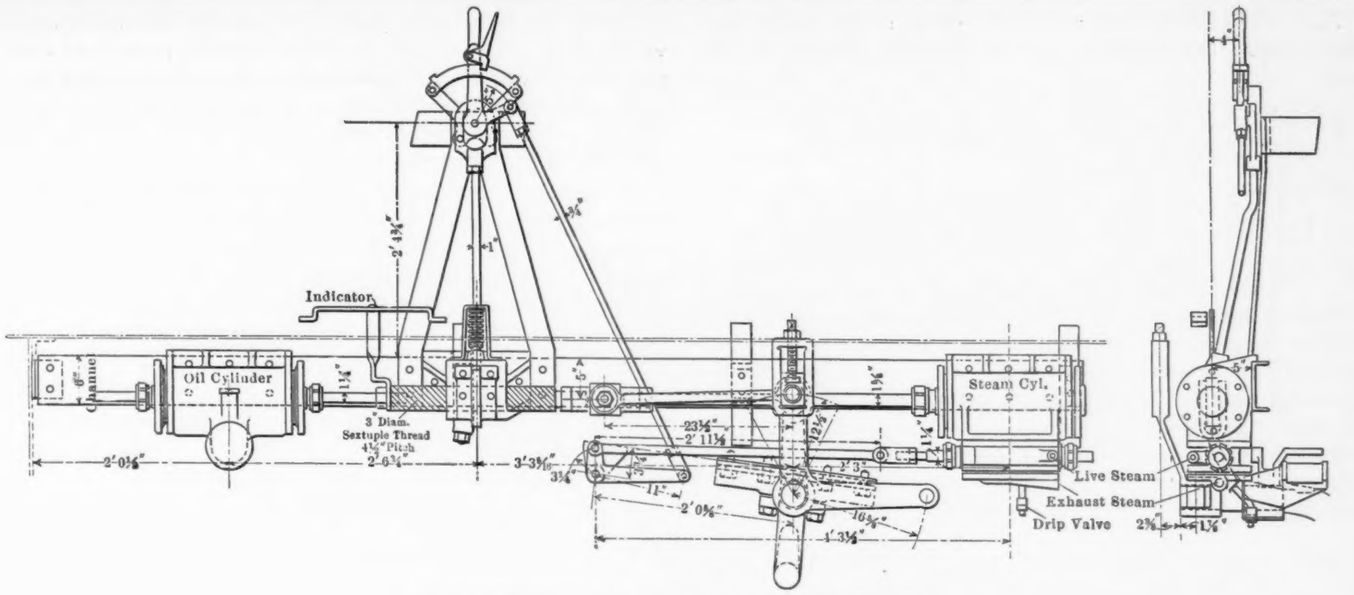


FRONT END ARRANGEMENT SHOWING SWIVEL AND EXPANSION JOINT IN EXHAUST PIPE.

the matter of simplicity, accuracy of adjustment and reliability it has many advantages. A 6 in. steam cylinder controlled by a slide valve in the steam chest below it forms the source of power for operating the reverse mechanism of both sets of gears. The piston rod in this cylinder is connected to a screw with very large pitch, which in turn connect to the piston rod of the oil cylinder, that acts as a dash pot. Just ahead of the screw is a block forming part of the piston rod to which are hinged a double link that connects to the upright arm forged integral with the reverse shaft. To the reverse shaft is also keyed the lifting arm for the high pressure gear, which has a slotted upper end carrying the block to which the reach rod from the low pressure gears extend. In this manner it is possible to adjust the movement of the valve of the low pressure cylinders independent of the high pressure valves, as was explained on page 84 of the March issue.



RECEIVER HEADER ON LOW PRESSURE CYLINDERS



STEAM REVERSE GEAR—CANADIAN PACIFIC MALLET.

The large screw mentioned as forming part of the connection between the oil and steam cylinders is 3 in. in diameter, having a sextuple thread, 4½ in. pitch. On this screw is carried a large nut with a notched ring. This nut is held in place by a frame extending out from the side of the firebox and because of the coarse thread it easily revolces as the gear is moved. The latch from the lever sets into the notches in the ring, preventing its movement and thus locking the gear in any desired place. The lever is carried on a standard at the proper height and connects to the slide valve of the steam cylinder through a bell crank, as is shown in the drawing. The latch at the large nut is so connected that lugs on the reverse lever will lift it whenever the lever is thrown in either direction.

In operation, the small lever is thrown forward, for instance, which movement first unlatches the large nut and then moves the slide valve to the left (referring to the large drawing). This admits steam to the left side of the piston and carries the lift shaft toward the right. When it has moved the desired distance, as shown by the indicator, the operating handle is brought to the center, shutting off the steam and at the same time dropping the latch into the notches on the large nut and holding the whole gear securely.

LINE SHAFT DRIVE AND INDIVIDUAL MOTOR DRIVE IN MACHINE SHOPS.*

A. G. POPCKE.

Power for the operation of machine tools may be furnished either by individual motors or from a line shaft. In laying out an installation of machine tools, the relative merits of the different methods of drive should be carefully considered. The first cost of drive from a line shaft is usually less than by individual motors. In a great many cases a line shaft drive has been installed without giving due consideration either to the advantages or the savings which can be effected by an individual motor drive.

The writer has at hand a number of experimental tests from which the following analyses have been obtained. Formerly practically all shops were driven from long line shafts and the speed regulation was very poor. A break-down anywhere in the shop would then shut down the whole system. So simple a thing as a belt leaving its pulley was likely to cause a cessation of work for a considerable length of time. More recently the steam engine has been replaced in many cases by one large motor, thus securing more uniformity in speed regulation. Then came the division of tools into groups with an individual motor for each group. By this method even better speed regulation is obtained and there are fewer general delays.

For most kinds of service, however, the advantage of making each tool independent of others has become evident to close observers. It is found that with individual motors, higher speeds and deeper cuts are possible. The water-hardened steel cutting tools formerly used would not permit this, nor was the structure of the old line-shaft-driven tools strong enough to stand the additional stresses due to heavier cuts. High-speed steel came to meet the first need, and stronger construction soon brought the machine tools in line. To the advent of the electric motor, then, can be ascribed the commercial development of high-speed steel and many improvements in machine tool construction.

Increased economy in the operation of manufacturing machinery can be effected in two ways:

1—By reducing the power required to operate the machinery.

2—By reducing the time required for a given operation, or, in other words, increasing the output in a given time.

When confronted with the problem of deciding between the continued use of an existing line shaft or individual motor drive, or when deciding between the two methods for a new installation, the problem should be impartially considered in all its phases, somewhat as outlined in Table I. This table includes every important item to be considered, except one, and in every case the advantage is with the motor.

Comparative first cost is possibly the first consideration to enter the mind of most men, and this is the one consideration purposely omitted from Table I. That this consideration is of relatively minor importance, is evident when the saving in power consumption and in time made possible by the use of individual motors is considered.

ECONOMY IN POWER CONSUMPTION.

In order to determine the power required to drive line shafting and to obtain data for making accurate estimates, tests have been made by the aid of a graphic recording meter on motor-driven line shafts. The fact that these shafts were motor-driven gave them some advantage over engine-driven shafts, and made accurate measurements possible, otherwise the method of driving the line shaft need not be considered here. In each case the line shaft was belted to short counter-shafts from which the machine tools were driven. In the following discussion all references to the power required to drive the line shaft are understood to include the power requirements of the counter-shafts and connecting belting.

* From the *Electric Journal*.

Test No. 1.—This test was made on a lightly loaded line shaft driving three machine tools, the conditions being as follows:

Length of main shaft, 115 feet.
Diameter of main shaft, 3 inches.
Self-oiling bearings every eight feet; dimensions 3 in. x 12 in.
Couplings every 24 feet.
Driving motor, 40 h. p., 720 r.p.m.
Machine tools—
One 14 ft. boring mill; maximum power requirement... 3 kw.
One 48 in. x 10 ft. planer; maximum power requirement 2 kw.
One 10 ft. x 20 ft. planer; maximum power requirement 3 kw.

Maximum power requirement with all tools working at maximum output .... 8 kw.

The test showed that 4.5 kw. input to the motor was required to drive the line shaft with no machines operating. Tests lasting over several hours showed that the machines while operating under existing shop conditions required an additional average input of only about 1.5 kw.; that is, the total motor input was approximately 6 kw. Of this amount the line shaft required 75 per cent. and the machine tools only 25 per cent., including their friction and power requirements.

The input to the motor, when driving the line shaft alone, was 3.5 kw. Tests of several hours' duration showed an average of 2.1 kw. additional to drive the tools under practical operating conditions. That is, the total average motor input was 5.6 kw., of which the line shafting absorbed 63 per cent. and the machines only 37 per cent.

The annual cost of power, at $0.02 per kilowatt-hour, would be 5.6×2,808×$0.02=$314.50, of which 63 per cent., or $196.56, is chargeable to line shafting and the remainder, $117.94, to the tools. The maximum input to the motor observed during the test was 6.6 kw.; but assuming, as before, a maximum average of one-half full capacity, the machines would require 6.5 kw., making a total average input of 10 kw., of which the line shaft would require 35 per cent. and the tools 65 per cent. The power cost, at $0.02 per kilowatt-hour, would then be 10×2,808×0.02=$561.60 per annum; 35 per cent., or $196.56, being chargeable to the line shaft, and 65 per cent., or $365.04, to the tools.

Item.	Line Shaft Drive.	Individual Motor Drive.	Advantage of Individual Motor.
1—Power consumption	Constant friction. Loss in shafts, belts and motor. Power for cutting.	Friction loss (motor and tool only) and useful power only while working	Less power required
2—Speed control	No. speeds = No. cone pulleys × No. gear ratios.	No. speeds = No. controller points × No. gear ratios	More speeds possible. Time saved in making speed adjustments
3—Reversing	Clutch and crossed belt.	Reversible controller	Time saved in reversing
4—Adjusting tool and work	Stopping at any definite point very difficult	Can be started in either direction and stopped promptly at any point	Time saved in setting up and lining up a job
5—Speed adjustment	Large speed increments between pulley steps	Small speed increments between controller steps	Time saved in obtaining proper cutting speed
6—Size of cut	Limited by slipping belt Large belts hard to shift	Limited by strength of tool and size of motor	Time saved by taking heavier cuts
7—Time to complete a job			Much less time required as indicated for previous items
8—Liability to accidents	Slipping or breaking belts. Injury to machine tool, cutting tool or prime mover	Injury to machine tool, cutting tool or motor	Much less liability to accidents
9—Checking economy of operations	Close supervision required. Very difficult to locate causes of delay	Accurate tests possible by means of graphic records	Causes of delay and the remedies easily located without personal supervision
10—Flexibility of location	Location determined by shafting, and changes are difficult	Location determined by sequence of operations. Changes readily made.	Greater convenience in handling work and increased economy of operation. More compact arrangement possible

TABLE I—COMPARISON OF LINE SHAFT DRIVE AND INDIVIDUAL MOTOR DRIVE.

Test No. 3.—This test was made on a heavily loaded line shaft driving 12 machine tools. The length of the line shaft was 300 feet, all other dimensions of the shaft, bearings and couplings being the same as in test No. 1. The driving motor was 40 horse-power, 720 r.p.m., and the tools consisted of three planers, five boring mills, three radial drills, one slotter and one milling machine.

Assuming the cost of power at two cents per kilowatt-hour, and that a working year contains 2,808 hours (54 hours per week), the cost of power for the foregoing installation would be 6×2,808×$0.02=$336.96 per annum, of which 75 per cent., or $252.72, is chargeable to the line shaft. This assumption of power cost is low for many installations, especially for small, isolated plants.

While making the foregoing tests the machines were not all operating at full capacity. Assuming the best practical average operating conditions to be full capacity of each tool one-half of the time or one-half capacity full time, the machines would require 4 kw. The total average input to the motor would then be 8.5 kw., of which the line shaft would absorb 53 per cent. and the machine tools 47 per cent. The power cost at two cents per kilowatt-hour under the foregoing assumptions would then be 8.5×2,808×$0.02=$477.36 per annum, of which 53 per cent., or $252.72, is chargeable to the line shaft.

Test No. 2.—This test was made on a moderately loaded line shaft driving five machine tools. The details of the shaft construction were the same as in Test No. 1, and the other conditions were as follows:

Driving motor 30 h. p., 720 r.p.m.
Machine tools—
One 14 ft. vertical boring mill; maximum power requirement .... 3 kw.
One 5 ft. radial drill; maximum power requirement.... 2 kw.
One 7 ft. radial drill; maximum power requirement..... 2 kw.
Two No. 8 Niles horizontal boring, drilling and milling machines; maximum power requirement, each........ 3 kw.

Maximum power requirement with all tools working at maximum capacity ....13 kw.

The input to the motor for the shaft alone was 6.3 kw., and the average additional input for the machine tools was 8.0 kw., making a total average input of 14.3 kw. Of this total the shafting absorbed very nearly 44 per cent. and the tools the remainder, or 56 per cent. The annual cost of power, with the former assumptions, would be 14.3×2,808×0.02=$803.09, of which 44 per cent., or $353.36, is chargeable to the shafting.

If all the tools driven from this line shaft were working simultaneously at full capacity they would require a motor input of 42 kw. The maximum input to the motor observed during the test was 19.4 kw. Assuming, however, maximum practical average operating conditions to be half capacity full time, the machines would require 21 kw., making a total input of 27.3 kw., 23 per cent. being chargeable to the line shaft. The power cost at $0.02 per kilowatt-hour would then be 27.3×2,808×0.02=$1,533.17 per annum, of which $353.36 is chargeable to the line shaft.

Economy in Time.

The relative time economy of motor drive and shaft drive is best illustrated by comparing the two methods for a given installation. The overhead charges, consisting of interest, in-

surance, taxes, repairs to plant, salaries, etc., are practically the same for either method of driving.

For purposes of comparison, the cost of equipping the tools referred to in Test No. 2 with individual motors will be considered, and the saving to be effected thereby estimated. The data used for making the comparison are based either on actual tests or assumptions warranted by experience.

TABLE II—MACHINE TOOLS AND OPERATING COSTS OF TEST NO. 2.

MACHINE TOOL	Operating Costs		Individual Motor	
	Overhead	Wages	HP	Cost Including Controller
14 ft. Vertical Boring Mill.....	$1 50	$0 35	10	$370
5 ft. Radial Drill..............	50	0 30	5	255
7 ft. Radial Drill..............	1 20	0 30	7.5	290
No. 8 Horizontal Boring Mill..	3 00	0 35	5	200
No. 8 Horizontal Boring Mill..	3 00	0 35	5	200
Total Costs........	$9 20	$1 65		$1 315

The overhead cost and wages per year of 2,808 hours (54 hours per week), for either line shaft or motor drive, from Table II, are:

Overhead ....2,808 × 9.20 =	$25,833.60
Wages ....2,808 × 1.65 =	4,633.20
Total	$30,466.80

The cost of a large motor and line shaft drive for the foregoing installation is approximately $900. The cost of the individual motors is $1,315, as indicated in Table II. Assuming that the cost of attachments, changes in tools to fit them for motor drive, wiring, etc., is the same as the cost of line shaft drive, $900, the total cost of the individual motor installation is $1,315+$900=$2,215.

The cost of power for line shaft drive, as determined from Test No. 2, is $314.50 per year, with power at two cents per kilowatt-hour, of which $117.94 is chargeable to the tools. In some cases the installation of individual motors has resulted in more than 20 per cent. increased output, but assuming a conservative estimate, ten per cent., the power cost can safely be placed at $130 per year. Calculating interest on the cost of the machine tool at six per cent. and depreciation at ten per cent., the operating costs can be compared as follows:

	Line Shaft.	Indiv. Motors.
Overhead and wages..........................	$30,466.80	$30,466.80
Interest and Depreciation @ 16% on costs of installation, $900 and $2,215, respectively.....	144.00	354.40
Power	314.50	130.00
Total	$30,925.30	$30,951.20

This comparison shows a balance in operating costs of $30,951.20—$30,925.30=$25.90, favoring the line shaft drive. Experience has shown, however, that tools equipped with individual motors will turn out at least ten per cent. more finished product than they will when line-shaft-driven. Assuming that the earnings of the shaft-driven tools are just equivalent to their operating costs, an increase of ten per cent. in output makes $0.10×$30,925.30=$3,092.53 increased earnings per year obtainable by the use of individual motors with scarcely any increase in arrangement for driving a shop in any given case.

With the asssumed maximum practical operating conditions given under Test No. 2, the power cost for line shaft drive is $561.60, $365.04 being chargeable to the tools. Assuming ten per cent. increased output with individual motor drive, the cost of power would be about $400. The comparison of line shaft drive and individual motor drive would then be as follows:

	Line Shaft.	Indiv. Motors.
Overhead and wages..........................	$30,466.80	$30,466.80
Interest and depreciation....................	144.00	354.40
Power	561.60	400.00
Total	$31,172.40	$31,221.20

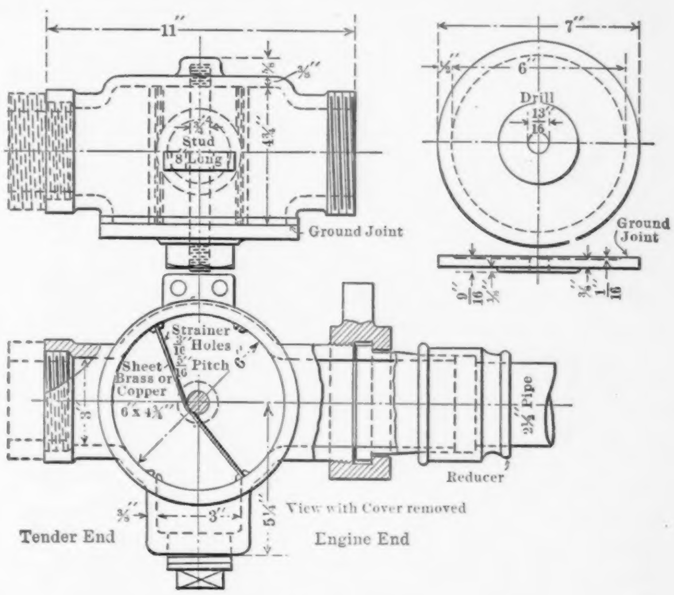
This assumption leaves a balance of $48.80 favoring line shaft drive, provided the increased output with motors be not considered. When allowance is made for ten per cent. increased output, the comparison shows $3,117.24—$48.80=$3,068.44 per year favoring individual motor drive.

The foregoing analyses show that the only consideration favoring line shaft drive—namely, lower first cost—is much more than overbalanced by the increased production possible with motor drive; also, that the cost of power, though in favor of motor drive, plays a very small part in the determination of operating expenses in a machine shop. It is to be noted also that the higher the cost of power the more favorable the proposition becomes to individual motor drive.

The foregoing shows that the question of whether or not to use individual motor drive in any particular case is a financial one and must be properly analyzed. The best way for a shop manager to solve this problem is to be guided by the following question: What investment shall I make and how shall I equip my shop so as to obtain the greatest income upon the investment? Individual drive means an increase in investment, but in nearly all cases a much greater percentage income will be reaped than if line shaft drive was employed. The above discussion shows in a general way how to determine the best expense, leaving a net annual profit of approximately $3,092.53—$25.90=$3,066.63, favoring the motor drive.

TANK STRAINER.

In the design of tank strainer shown in the illustration, the connection to the tender is from the left and a copper screen is set at such an angle and location that the flow will force any solid particles larger than the perforations off from the screen and into the receptacle below. At the same time the screen is practically vertical across the flow of the water and thus offers the least obstruction. It is accessible for cleaning by the removal of a single nut, which releases the head having a ground



joint with the body of the valve. The removal of a plug at the bottom not only permits the flushing of the strainer but also drains all connections between the tank valve and the injector.

This strainer is very simple in its arrangement and construction and was designed in the mechanical engineer's office of the Illinois Central Railroad, where it is being put into very extensive use.

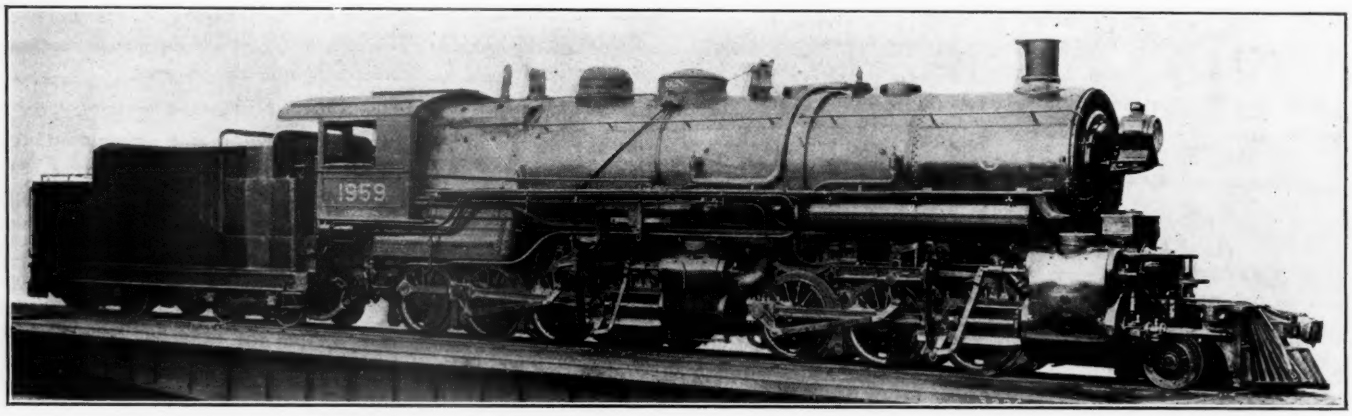
NEW ELECTRIC LOCOMOTIVES.—The Illinois Traction System is building six heavy electric locomotives at its shops in Decatur, Ill. They will be equipped with four General Electric, 600-h.p. motors with Sprague-General Electric, multiple unit type M control. The trucks will be furnished by the American Locomotive Company and the air-brakes will be Westinghouse EL. The locomotives will resemble in general outline the steel turtle-back cars in use on this line, and will be 34 ft. long, 9 ft. 3 in. wide. They are to be equipped with M. C. B. couplers and steel pilots.

MALLET ARTICULATED LOCOMOTIVES, 2-6-8-0 TYPE

GREAT NORTHERN RAILWAY.

The Baldwin Locomotive Works have recently completed ten more Mallet articulated compound locomotives for the Great Northern Railway. The general features of the locomotives of this type heretofore used on this line have been published in this journal.* The principal changes embodied in the design of the new engines are as follows:

The use of a separable boiler, with a feed-water heater in the front section, and an Emerson superheater in the rear section. A change from the 2-6-6-2 to the 2-6-8-0 wheel arrangement. An increase in the cylinder diameters, and the use of piston instead of slide valves. A general revision in the design of the more important details, such as the articulated frame connection, reversing gear, etc.



ARTICULATED LOCOMOTIVE OF THE 2-6-8-0 TYPE—GREAT NORTHERN RAILWAY.

BOILER.—The boiler is straight topped, and the firebox (Belpaire type) is similar to that used in the previous Great Northern engines. The back head slopes forward, and is stayed above the crown by gusset plates. These plates are cut out to accommodate the transverse bolts which stay the outside shell above the crown. The barrel is composed of two rings, and contains 307 tubes 15 ft. long. Thirty-two of these tubes are 5 in. in diameter, while the remaining 275 are 2¼ in. in diameter. In front of the tube sheet is a sohrt combustion chamber, surmounted by a manhole. The separable boiler joint surrounds the front end of this chamber. The feed water heater is 5 ft. 2 in. long over tube sheets, and contains 582 tubes, each 2¼ in. in diameter. These tubes are distributed over the entire cross section, except at the center, where the heater is traversed by a flue 11 in. in diameter. This flue is riveted to the tube sheets, which are suitably flanged for the purpose.

STEAM AND EXHAUST PIPING.—The dome is located immediately in front of the firebox, and the throttle communicates with a horizontal dry pipe of ordinary construction. This pipe terminates in the combustion chamber, where it is connected, by means of a tee-head, with the superheater headers. These are, in shape, not unlike ordinary steam pipes.† Each header is divided into two compartments, and has cast upon it suitable lugs which are bored out to receive the superheater pipes. These pipes are expanded into the headers and are arranged with a double loop in each large boiler tube. The loops are connected by cast steel return bends. The 5 in. boiler tubes are grouped in four rows, two of which are placed back of each header.

The superheated steam is conveyed to the steam chests through short horizontal pipes. These are connected to the superheater headers through a saddle casting bolted to the under side of the combustion chamber, and cored out to convey the high pressure exhaust steam to the receiver pipe. This casting, furthermore, is provided with a cinder pocket for cleaning the combustion chamber.

The high pressure exhaust steam, after passing through the saddle casting, is conducted by a cast iron elbow, to a horizontal pipe located in the large central flue of the water heater. A second elbow, placed in the smokebox, then conducts the steam to the flexible receiver pipe. This pipe is placed on a sharp inclination, and is provided with a ball-joint at each end and one intermediate slip joint. The arrangement of the final exhaust pipe calls for no special comment.

CYLINDERS, VALVES AND VALVE GEAR.—The cylinders are 23 and 35 by 32 inches, and with 55-inch driving wheels and a steam pressure of 200 pounds, the calculated tractive effort is 82,000 pounds. With 359,600 pounds on driving wheels, the resulting factor of adhesion is 4.38. The high and low pressure cylinders are cast independent of their respective saddles. The high pressure valves are 13 in. in diameter, and arranged for inside admission; while the low pressure valves are 15 in. in diameter and arranged for outside admission. The by-pass valves are of the Pennsylvania R. R. style. The relief plates are of cast steel, and each is formed in one piece with a central spindle guide. The two reverse shafts are connected by a jointed reach rod, placed on the center line of the engine, with a flexible joint in the center of the high pressure saddle. The Ragonnet power gear is used, and its cylinder is bolted to the right-hand side of the boiler shell immediately ahead of the high pressure reverse shaft.

FRAMES AND RUNNING GEAR.—The frames are of cast steel, and are arranged with a single articulated connection. The low pressure cylinders are bolted and keyed to a steel box casting, which constitutes part of the framing system for the forward engine. This arrangement is reported to have given excellent satisfaction on heavy Mallet locomotives built by the Baldwin Locomotive Works during the past year.

The equalization of the rear engine is continuous, and is arranged with leaf springs over the boxes of the fourth and fifth pairs of drivers. The frames are supported under the firebox by three inverted leaf springs on each side, and these are connected to yoke equalizers placed over the boxes of the sixth and seventh pairs of drivers.

The equalization of the front group of wheels is arranged with yokes over the boxes of the leading drivers. These yokes are connected to a transverse beam of cast steel and from this beam is suspended an inverted leaf spring. The back end of the forward equalizer rests on the middle of this spring, and the equalizer is fulcrumed under the steel box casting which supports the low pressure cylinders.

OTHER DETAILS.—The front section of the boiler is carried on

* See 1906, pp. 371, and 1907, pp. 213.
† See AMERICAN ENGINEER, Feb., 1910, pp. 64.

two supports, both of which are under load. The rear support is placed under the water heater, and the front support under the smokebox. The latter is fitted with the controlling spring.

Sand is delivered to the rear group of wheels from a box placed over the boiler, and to the forward group from a separate box located well down, between the low pressure cylinders.

The injectors are non-lifting, and are placed right and left under the cab. They force water directly into the heater, keeping the latter constantly filled. The outlet from the heater is placed on the top center line, and water is delivered to the boiler proper through two checks, placed right and left immediately back of the front tube sheet.

The smokebox contains a high single nozzle, in front of which is placed the adjustable diaphragm. A petticoat pipe is located under the stack. The smokebox arrangement is characterized by simplicity and freedom from draft obstruction.

TENDER.—The tender is designed in accordance with Great Northern practice. The frame is composed of 12 in. channels, and the trucks are of the equalized pedestal type with cast steel center, steel-tired wheels.

The satisfactory results so far given by Mallet locomotives on the Great Northern is evidenced by the fact that up to the present time 77 of these engines have been built for this company by the Baldwin Locomotive Works. As the new locomotives are equipped with feed-water heaters and superheaters, it should be possible to accurately determine the respective econc mies resulting from the application of such devices.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	82,000 lbs.
Weight in working order	378,300 lbs.
Weight on drivers	359,600 lbs.
Weight on leading truck	18,700 lbs.
Weight of engine and tender in working order	526,000 lbs.
Wheel base, driving, front	10 ft.
Wheel base, driving, back	15 ft.
Wheel base, total	43 ft. 11 in.
Wheel base, engine and tender	76 ft. 2½ in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.38
Total weight ÷ tractive effort	4.60
Tractive effort × diam. drivers ÷ total heating surface	783.00
Total heating surface ÷ grate area	74.00
Weight on drivers ÷ total heating surface	62.50
Total weight ÷ total heating surface	65.60
Volume equivalent simple cylinders, cu. ft	24.10
Total heating surface ÷ volume cylinders	239.00
Grate area ÷ vol. cylinders	3.24
CYLINDERS.	
Kind	Compound
Diameter	23 and 35 in.
Stroke	32 in.
VALVES.	
Kind	Piston
Diameter, H. P.	13 in.
Diameter, L. P.	15 in.
WHEELS.	
Driving, diameter over tires	55 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6 x 12 in.
BOILER.	
Style	Belpaire
Working pressure	200 lbs.
Outside diameter of first ring	84 in.
Firebox, length and width	117 x 96 in.
Firebox plates, thickness	⅜ and ⅝ in.
Firebox, water space	F. 6, S. and B. 5 in.
Tubes, number and outside diameter	275—2¼, 32—5 in.
Tubes, length	15 ft.
Heating surface, tubes	3,038 sq. ft.
Heating surface, firebox	225 sq, ft.
Heating surface, total evaporating	3,263 sq. ft.
Superheater heating surface	480 sq. ft.
Feedwater heating surface	1,797 sq. ft.
Total heating surface*	5,780 sq. ft.
Grate area	78 sq. ft.
TENDER.	
Wheels, diameter	36½ in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	13 tons

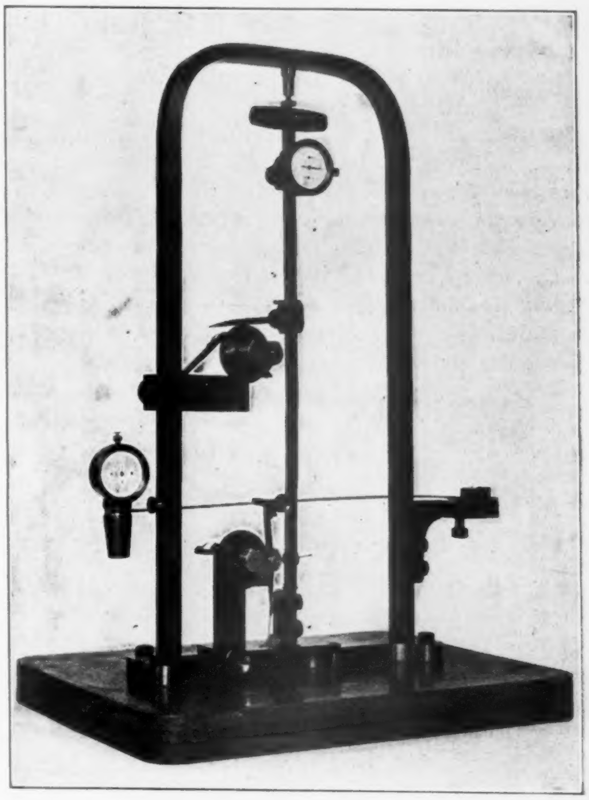
* Sum of the evaporating heating surface, 150 per cent. of the superheating surface and the feedwater heating surface.

NEW STORAGE BATTERY CARS.—Sixteen of the new Edison storage battery cars have been ordered by the officials of the Twenty-eighth and Twenty-ninth street crosstown line. In the three weeks' test of the car on that line it was operated at a cost of only 4.3 mills per mile.—*Ry. Elec. Eng'r.*

INSTRUMENT FOR TESTING TRACK.

The Pennsylvania Railroad has devised an instrument, which will accurately register every vibration, either vertically or horizontally, of a car attached to a regular passenger train, and thus permit accurate comparisons being made of the riding qualities of the track on any two sections of the road. This instrument is placed on the floor of the car, and is fitted with horizontal and vertical pendulums or bars of flexible steel secured at one end and having a a hammer or weight at the other. The vibration of the car causes these bars to vibrate and the dial located near the hammer registers the maximum amount of the movement and the number of vibrations. A form of cyclometer is attached to each bar and gives a record of the total distance covered by the vibrations, *i. e.*, the cyclometer will give the total movement of the flexible bar for the entire trip and hence a severe vibration will give a record which would require a large number of smaller ones to equal.

This instrument is used in determining the winners in the competition between the supervisors and their assistants, to whom each year a sum of nearly $11,000 is awarded in prizes for excellence in track maintenance. The test also includes observation of the movement of water in two glasses placed on the sills of the windows in the rear of the car and an allowance is also made for the relative speed of which the train is operating over any section. From these records a fairly accurate estimate can be made of the riding qualities of the various sections of the track and the decisions for the award of the prizes arrived at.



INSTRUMENT FOR TESTING TRACK—P. R. R.

AMPERE HOUR METERS ON NEW YORK CENTRAL.—The New York Central has recently installed ampere hour meters on all of its diners and buffet cars which are electrically lighted. This equipment includes about 35 diners and 25 buffet cars. Ampere hour readings have been found to be especially advantageous in car lighting service on this road inasmuch as one coach yard in which these cars are finally placed has so little clearance between tracks that it is practically impossible to open the battery doors, and accordingly gravity readings of the battery are out of the question.—*Ry. Elec. Eng'r.*

RAILROAD ELECTRIFICATION *

In the few remarks which follow it is not the purpose to discuss the paper directly but to present certain aspects of the general subject, of more or less general character, which are the outgrowth of the speaker's ten years' experience in trying to demonstrate to railway men the various ways that electricity can be advantageously utilized in connection with various railway problems.

There are a few general items of railway transportation problems that have a bearing on, and explain the apparent slow progress made in trunk line electrification, such as:

1st. The question of mere method of train haulage is only a small part of the question.

2d. The advocates of electric traction have been dwelling on only a small portion of the various elements involved in the cost of transportation.

3rd. The electrical engineer has had a tendency to prejudice his case in advance by apparent lack of knowledge, or clear conception of the elements composing the problem.

4th. Unfortunately the effectiveness of the advocated engineering recommendations are somewhat diminished by the fact that the advice given is not always disinterested.

5th. The electrical achievements thus far, while mainly confined to passenger traffic, have shed little light, except in special cases, on the larger problem of freight train operation.

A review of some of the problems and operating results of railway managers may lead us to a better appreciation of the magnitude, variety and rare skill necessary for the achievement of success. For example:

1st. The freight rate per ton mile in Great Britain is 2.31 cents, against ¾ cents in this country. The revenue per ton mile, in Germany, is 1.41 cents, or nearly twice the figure for the United States. This also in face of the fact that the wages per man in the United States is 82 per cent. greater than in Germany and 140 per cent. greater than in England.

The operating ratio, *i. e.*, the ratio of expenses to gross earnings in the United States, is 67.5 against 69.1 for Germany and 63 in England.

2nd. The average ton of freight handled by our railways is moved 33 miles for the same cost one pays to the coal dealer to transport a ton of coal across his lawn.

3rd. Notwithstanding the increase in operating costs, during the past ten years, due to advance in wages, materials and supplies, the operating ratio or proportion of operating expenses to gross earnings, has advanced only from 67.06 per cent. in 1897 to 69.67 per cent. in 1907, whereas the advance in cost of labor and materials, during the same period, if it was not checked by other factors, would have practically wiped out net earnings. How then did the railways escape bankruptcy? The answer is found from the following figures taken from the Interstate Commerce reports, which show the enhanced efficiency of train movement. This is essentially the record of management:

Year to June 30.	Tons Carried One Mile (Millions).	Freight Train Mileage (Millions).	Average Train Load, Tons.	Passengers Carried One Mile (Millions).	Passenger Train Mileage (Millions).	Passengers per Train Mile.
1897	95,139	464	204	12,256	335	37
1898	114,077	503	226	13,379	334	39
1899	123,667	507	243	14,591	347	41
1900	141,596	492	270	16,038	363	41
1901	147,077	491	281	17,353	385	42
1902	157,289	499	296	19,689	405	45
1903	173,221	526	310	20,915	425	46
1904	174,522	535	307	21,923	440	46
1905	186,463	546	322	23,800	459	48
1906	215,877	594	344	25,167	479	49
1907	236,601	629	357	27,718	509	51
Increase per ct.	148.7	35.5	75	126.1	51.9	37.8

These figures represent what the men in charge of the railways have done, through the agency of capital and brain power, applied to the reduction of grades, elimination of curves, installation of additional side tracks and terminal yards, the purchase of larger and better cars, locomotives, etc.

The foregoing figures (mainly from D. Crombie, of the Grand Trunk Railway System, and a digest of the Interstate Commerce reports by E. W. Harden) give an inkling of the railway managers' problems and the broadminded views such results naturally produce, necessitating a long look ahead, and would naturally lead the railway manager to take the initiative as regards the consideration of electricity as an element in the problem.

4th. The efficiency of transportation is such that the average distance on all railways, each shipment travels, is 131.7 miles; the average mileage per car is 23.5 miles per day. At this rate, each car load shipment consumes $\frac{(131.7)}{(\ 23.5)}$ 5.6 days.

Again, the average mileage per month, for a freight locomotive, is 3,000. By double crewing or pooling, this mileage can be increased approximately only 25 per cent., which goes to show that the mileage actually made is independent of the potential capacity of the locomotive or the method of propulsion.

Of the foregoing average of 5.6 days per shipment, the part which the element of mere translation plays, is only six per cent. of the total time, so that if this was entirely eliminated the total saving would be insignificant.

Per contra, there is a great opportunity for the legitimate employment of electricity in effecting economies in the balance of the cycle which would show up very attractively. The possibilities in this regard are foreshadowed by the unique and well nigh revolutionary achievements in loading and unloading vessels at the ports on the Great Lakes.

The speaker fully recognizes the possibilities of electric operation, as to gain in capacity, etc., where the circumstances admit of utilizing this capacity, at least in passenger train work, but this splendid inherent capacity is not possible of realization in freight service at the present time because the transportation limitations which now vitally control the mileage of the steam locomotive, would operate and prevent the electric locomotive doing any better with the added handicap of doubling the capital investment.

The foregoing is respectfully submitted in the hope of suggesting, first, the kind and quality of railway talent to be met with, and second, the sort of knowledge, experience and mental furnishing demanded of the electrical engineer in order to make effective headway in electric exploitation in the steam railway field. It is quite obvious that we must understand the railway language and possess adequate knowledge of the railway game.

There was one thought I really meant to bring out a little more clearly, but I refrained from doing so because I went into details quite largely in the discussion* to which Mr. Darlington referred in opening the paper; but I think it is a thought that will appeal to all steam railroad men—the average monthly mileage that a freight locomotive makes is 3,000 miles. The limitations which govern this low mileage are not due to mechanical or engineering limitations or causes for which the motive power department is responsible. The potential possibility of an engine is such as to be capable of making an average of 9,000 miles per month, provided a clear road was available; but what limits the mileage of locomotives are terminals and passing sidings. So that if we had the proper terminals and side tracks, as President Hill of the Great Northern has said, we could more than triple the present monthly mileage of our locomotives.

Now, a great many of our electrical friends, myself included, in the early stages of the art, assumed that that 3,000 miles capacity represented the physical limitations of the steam locomotive, and, knowing the ability of the electric locomotives to perform continuous service for 23 hours out of the 24, immediately assumed from the fact that that represented the difference in potential possibility between the electric locomotive and the steam locomotive. Now, the facts are these: Inasmuch as the limita-

* A discussion by L. R. Pomeroy of a paper, "The Present Status and Tendencies of Railroad Electrification," by F. Darlington before the Central Railway Club.

* See AMERICAN ENGINEER, p. 41, February, 1910.

tions are entirely outside of the motive power department, and due entirely to transportation considerations, there is no assurance that we could get any more mileage out of the electric locomotive than we are now getting out of steam, with the added handicap of assuming a much larger capital charge—two things in the speaker's judgment that will have to be considered. In the first place, these terminals will have to be provided, and adequate side tracks furnished, so that enough mileage can be made to justify the expenditure; and the second point is that the improvement and reduction in first cost from the electrical side has got to be of a very marked nature before electrification of trunk lines can become very general.

HIGH SPEED FORGING PRESS.

Hydraulic forging presses have been very generally used for forgings of large size because of the practical impossibility of satisfactorily working the metal to the center of the ingot under a steam hammer of any size. Such presses as have been in use for very heavy work are slow in operation and until recently the many advantages of forging work over hammer work were not available for light or moderate forgings because of this fact.

As much as ten years ago the metal workers of England and Germany started the development of a machine which would permit the use of forging presses on small and moderate size work without any sacrifice of time and with a decided improvement in the quality of the product. This effort was moderately successful, even at the start, and machines of this character have been in use in those countries for as much as ten years and at the present time the perfected machines are very extensively employed. The original design, however, was subjected to a long period of development before the present thoroughly satisfactory machines were obtained.

During the past two or three years metal workers in this country have recognized the advantages offered by the high speed forging presses and they are becoming decidedly popular. The United Engineering and Foundry Co., of Pittsburgh, has acquired the sole right to manufacture the machines which were developed by Davy Brothers, Inc., of Sheffield, England, who have been designers of steam hammers and hydraulic forging presses for many years and the illustrations show two sizes of the machines that are now being furnished by them.

These machines offer the advantages of press work over hammering at any point where a steam pipe may be carried and also have the additional advantage of actually reducing the cost of the work. Therefore not only may a more thorough working of the metal be affected, but it can be done at a lower price than by a steam hammer, while at the same time the danger to workmen from flying tools or pieces of forgings and the shocks and jars to the building and its foundation are eliminated. The maintenance cost of the machines is low, as might be expected when it is realized that the moving parts of these machines operate through inches and at comparatively low speed while a steam hammer operates through feet at high speed.

The development leading up to this finished machine is interesting and shows how the unexpected and apparently insurmountable difficulties have been overcome, resulting in a thoroughly practical and efficient design. This work has been done by Davy Bros., who began with a simple press deriving its pressure from a pump. This arrangement was not only very slow, but compelled the water at high pressure to pass through valves and relatively long lines of piping, many joints and had the other drawbacks of a large water system.

Following the pump operated press the next step in the development was the employment of a hydraulic intensifier, which made it possible to increase the pressure on the press from about 2,000 lbs. to 6,000 lbs. per square inch. This greatly reduced the size of the press cylinders and the volume of water required, bringing a press of large power down to practical dimensions. This type of machine, however, still required a pump and the system usually included a large accumulator in addition to the intensifier and required a number of valves and levers for its operation. This type of press was also slow, due to the number of valves operated and the slow speed of the intensifier and therefore an improvement was made by the employment of a steam intensifier which eliminated many of the difficulties that previously existed. In this case the pump was discarded and two pistons, having a ratio of about 40 to 1, were directly connected, steam operating the larger one which was set at the bottom, resulting directly in a high water pressure,

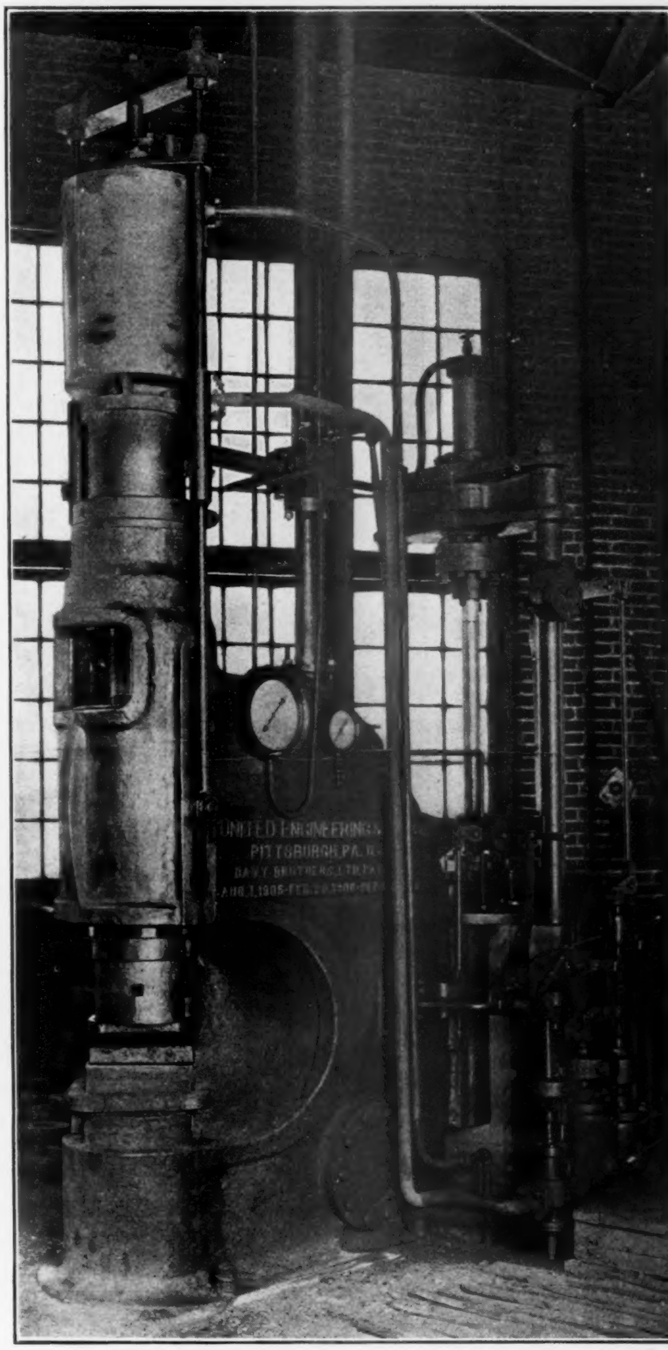


FIG. 1.—150 TON, SINGLE FRAME PRESS.

the steam being used only for the pressing stroke, since the weight of the pistons would perform the return stroke without assistance. Steam being highly elastic could be handled at a very high rate of speed and since the water pressure cylinder could be connected directly to the main cylinder of the press without valves, most of the former difficulties were eliminated. The size of the two water cylinders, *i. e.*, intensifier and press, was in a ratio of about 12 to 1, so that the press head while operating at the same time and in an amount 1/12 as far as the intensifier cylinder was subject to very accurate control. This arrangement gave a rapid working stroke satisfactorily and by the placing of a steam cylinder on top of the machine, ar-

ranged to take steam on one side of the piston only, the return stroke was also accomplished quickly. The return or balancing steam cylinder is arranged so that it does not exhaust the steam, but simply forces it back and forth in the main pipe.

While the principles of this machine were undoubtedly correct it is evident that unless the intensifier be of very large proportions the stroke of the press will be very short and a machine of sufficient capacity for ordinary forging work would be impractical on account of its size and the large amount of steam required to operate it. In order to overcome this difficulty it was decided that the proper thing to do was to lower the press head nearly in contact with the forgings by means of the steam balance cylinder, which is already provided for the return stroke and then put the intensifier into operation for the pressing stroke. This was done and only required the addition of a tank connected with the high pressure system and controlled by the check valve, so as to provide the varying amount of water required for different length strokes. The check valve in the line between the tank and press cylinder was arranged to open automatically as the head was lowered ready for operating and a lever was provided to raise the check valve when the press head was lifted, allowing the balance cylinders to force back into the tank an amount of water that will give the proper position of the press head. This arrangement greatly reduces the size of the intensifier and the amount of steam required to operate it, since it is in use only when forcing down the press head the amount that the forging is reduced.

It was found that this press was very satisfactory so far as one stroke was concerned, but when rapid action was required it was impractical to operate the number of valves or levers required. If these levers were operated out of time the result was disastrous to the machine or work and the speed of the machine was necessarily restricted to the speed of the operator in handling the levers. Therefore the next step was the development of a single lever control, which has now been perfected and one lever operates all valves and permits putting the press through an entire cycle of motions in one forward and back motion of the lever. The valves cannot be crossed and the press follows exactly the stroke of the hand lever, both as to speed and distance traveled. This lever is so arranged that back of the vertical center line corresponds to the light stroke from 2 to 6 ft., according to the size of the press, and forward of that line is the power stroke, 2½ to 6½ in., in accordance with the size of the press. With this arrangement the press can be brought down 2 to 6 ft. on top of the forging and the forging reduced from 2 to 6 in. by one motion of the hand lever. Then the press can be brought all the way back or any part of the way back by simply moving the lever to the required position. If the lever is only brought back to the center line the press head will return only the amount of the forging stroke, which can then be repeated as often as the lever can be moved. In practice this is as high as 150 strokes per minute in the small presses and 60 in the large ones. This stroke, which is repeated as often as the blow of a steam hammer, is at a much lower velocity, since the press moves only inches where the hammer moves feet.

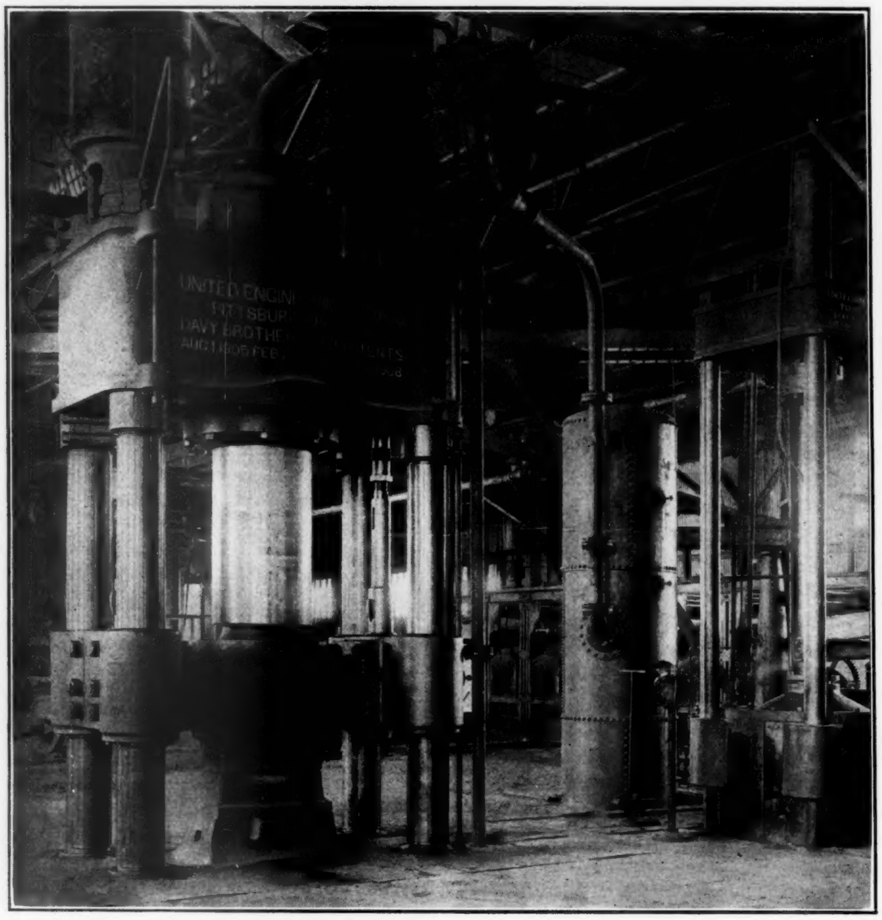


FIG. 2.—1,200 TON, FOUR COLUMN PRESS.

In cutting or punching, the hand lever can be set for a certain travel and the press head will ride forward just that distance, even though the resistance is suddenly and entirely removed. The machine does not require a large foundation and there is no vibration transmitted to surrounding buildings.

A large number of these presses have been furnished by the United Engineering and Foundry Co., which are working on a very diversified line of forgings, including cogging down ingots, wheel forgings, locomotive forgings and general work.

Some of the work which is being done on these machines is shown in the illustrations and clearly indicates the advantages of the press over the steam hammer in many classes of work.

Figure 3 shows a shaft 13½ in. in diameter and 19 ft. long with 27 in. diameter flanges which was forged on a 2,000 ton press from a 36 in. ingot in two hours, requiring but two heats.

In Figure 4 is shown a 14½ in. shaft 20 ft. long with a coupling at one end, which was forged on a 1,500 ton press from a 36 in. ingot in one heat, time required being one hour.

A 500 ton press made the disc shown in Fig. 5, which is 22 in. in diameter and 5 in. thick, from a 14 in. square ingot, in one heat, requiring 19 minutes. This includes punching the 4½ in. hole. The same size press made the hex nut shown in Fig. 6 in eight minutes, one heat being required.

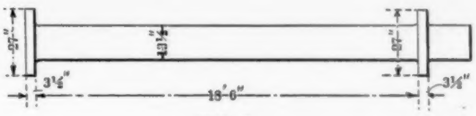


FIG. 3

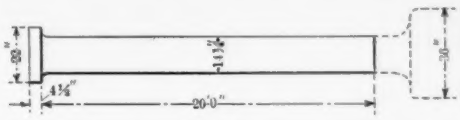


FIG. 4

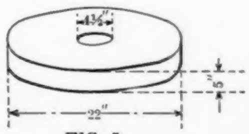


FIG. 5

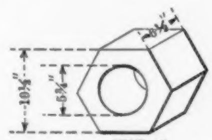


FIG. 6

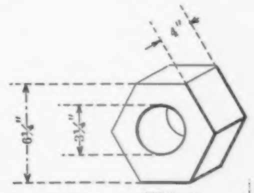


FIG. 9

FIG. 7

FIG. 8

EXAMPLES OF WORK DONE ON HIGH SPEED FORGING PRESS.

Figure 7 shows a shaft which was forged from a 7 x 7 in. billet on a 300 ton press in 12 minutes, in one heat.

A 150 ton press made the eccentric shaft shown in Fig. 8 from an 8 x 8 in. billet in 13 minutes, one heat being required. The same press made the hex nut shown in Fig. 9 from 5 in. round stock in 10 minutes, including the punching.

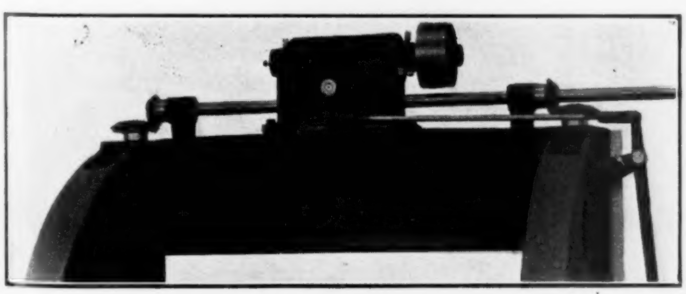
In cogging down ingots a 1,200 ton press working 16 x 16 in. ingots to 10 x 10 in. and cutting them up into pieces 18 in. long will average 16 tons per hour.

It is of course necessary for a machine doing work of this character that all the material and workmanship shall be of the very highest grade and special attention is being given to this by the manufacturers. They are also carefully providing for the easy and quick renewal of such parts as are subject to wear without dismantling any large part of the machine. Chilled surfaces and accurate grinding are used wherever desirable.

The address of the United Engineering and Foundry Company is Farmers' Bank Bldg., Pittsburgh, Pa.

PLANER ELEVATING DEVICE

An improved power elevating device as shown by the accompanying half-tones has recently been brought out in which the direct drive gears are used for lowering the rail and the compound gears, which would also give a reverse motion, are used



REAR VIEW, SHOWING OPERATING DEVICE.

to raise the rail, the compounding giving the necessary power, enabling the operator to raise the rail at comparatively slow speed and lower it at almost double the speed. The stand is bored out and fitted with bushings in such a manner that the top shaft which carries the pulley can be withdrawn with the bushings intact and inserted from the other side, so that when making various styles of drives, which are sometimes very complicated on account of the odd dimensions of motors, the pulley can be used on either side. As the power elevation device is used but very little it has been designed so that the pulley and top shaft are the only revolving parts, all of the gears being idle, when not in use.

This device is both powerful and very sensitive and is operated by two small clutches on the top shaft. The two oilers on

FRONT VIEW, SHOWING LOCATION ON PLANER HOUSINGS.

the top shaft and one at the end supply all the oil that is required, and by having a bearing on each side of the main driving gears, all danger of springing the shaft is eliminated. The rear view shows clearly the simplicity of the operating device. On the extreme right is shown the handle for manipulating the clutches and also the small handle for locking it in a central position so that it cannot be thrown in by accident.

The above device was designed and is supplied by the Cincinnati Planer Co., of Cincinnati, Ohio.

Pennsylvania Terminal in Manhattan.—The story of the Pennsylvania Railroad's great enterprise, its genesis, progress and completion, is told by C. M. Keys in an attractive article in the July number of *World's Work*. This story appearing under the title "Cassatt and His Vision," is fully illustrated and will be found very complete, as well as interesting, by any one interested in the successful venture planned by a great executive. In this article the author not only describes the great terminal, but also the details of financing this great project, which together with a few other improvements required the expenditure of about half a billion dollars in ten years. It includes a history of the forty years of effort to cross the Hudson River and a story of the work and policy of a great American railroad.